FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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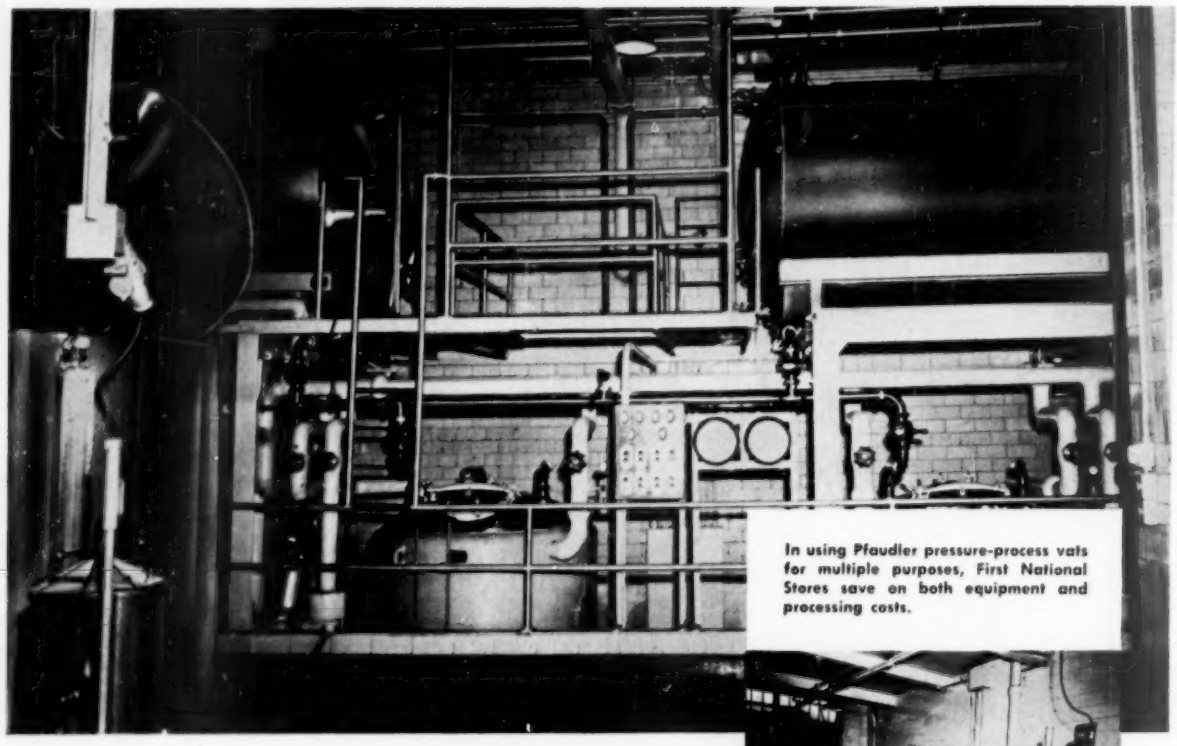

In using Pfaudler pressure-process vats for multiple purposes, First National Stores save on both equipment and processing costs.

# How to make sanitary tanks work harder in your food processing operations

As a means of cutting food processing costs, you ought to consider how various types of food handling vessels can be used to do more than one job.

For example, First National Stores, Portland, Maine, use the Pfaudler stainless steel equipment shown above for heating, holding, mixing and cooling. Frequently blending or mixing can be done in off-hours with savings in time and labor.

Pfaudler pressure-process vats are so designed that you can heat, hold, mix and cool liquids efficiently in a single unit. Liners of these vessels are built with spiral channels through which heating or cooling agents can be circulated at high velocity, forcing fast heat exchange from liner wall to product.

Agitation, of course, is an important aspect of fast heat transfer, too. Pfaudler process vats are equipped with agitators that accelerate the product contact with the walls of the vat. Two-speed drives enable you to vary the RPM best suited to each application.

Whether of vertical or horizontal construction, Pfaudler food processing vessels are sanitary in every detail.

Easy to clean, they assure freedom from contamination. From the standpoint of safety, they meet ASME standards. Much of this equipment is available in standard designs which mean lower initial costs.

So before you buy any equipment for blending, mixing, holding, preheating or storage, check first with Pfaudler. As a starter, send for Bulletins 871 and 884-FT-2, to see how this equipment might fit into your operations.

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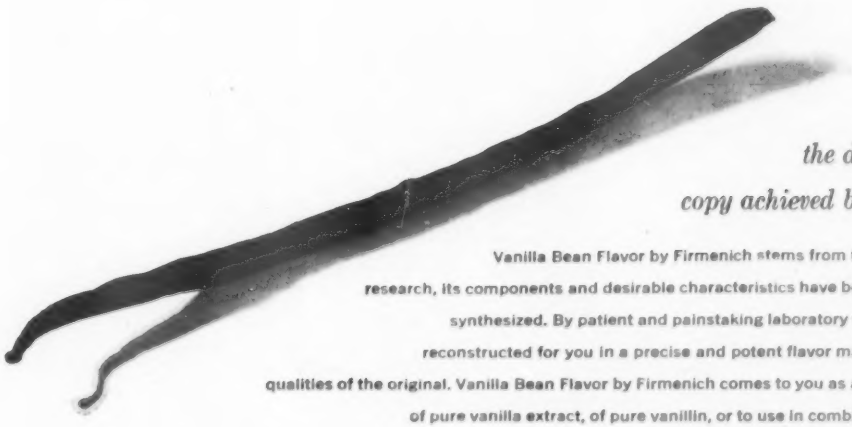
STRONGER THAN VANILLIN

## imitation vanilla bean flavor by Firmenich



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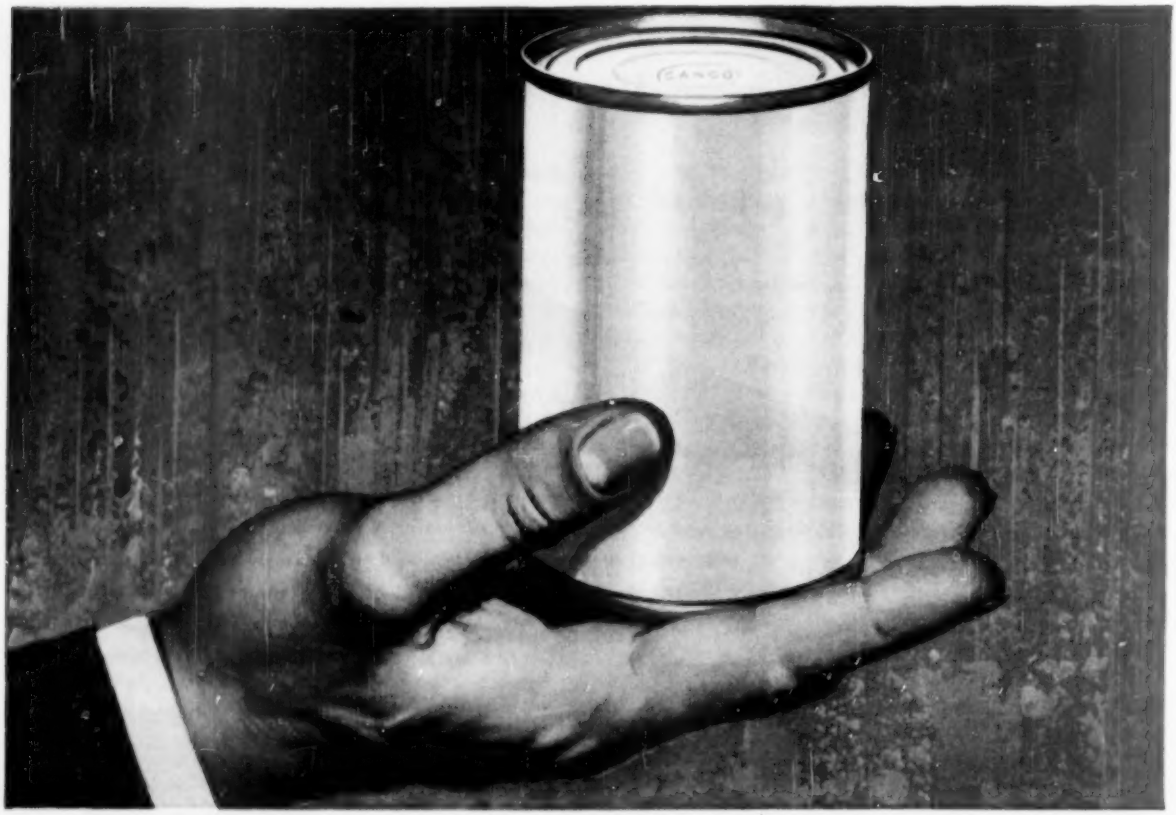

# The cans are different, but not the customers

**Between the "hole and cap" can**—now a collector's item—and today's streamlined Canco food container is a half century of progress.

Yet, many of the companies which purchased Canco's early cans are still on Canco's roster of staunch friends. Perhaps *your* company is one of them.

Why have so many companies—large and small—*consistently* done business with Canco? Because their experience has proven this:

**Canco offers** an unequalled combination of able people, conveniently located plants, research leadership, technical assistance, delivery service, quality and experience. As a result, packers get *what* they want . . . *where* they want it, and *when!*

If your company is not enjoying Canco services, isn't *right now* the time to start?

***Go first to the people who are first!***

## AMERICAN CAN COMPANY

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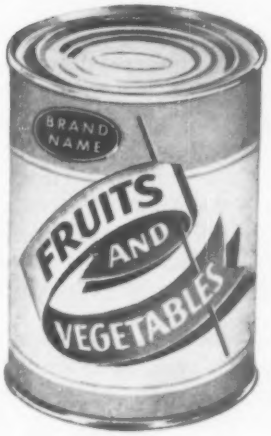
New York, Chicago, San Francisco; Hamilton, Canada




*The modern food can*—perfected by Canco—made commercial canning of fruits and vegetables possible; revolutionized the grocery business; helped raise the national level of nutrition and health.

Through the years, constant Canco pioneering and cooperation with the canning industry have brought forth widespread process and product improvement—opening new markets for canned foods of all kinds.

# The Vital Story of MARGARINE FORTIFICATION

*How They Made Margarine a Better Food*

*by* Science Writer

Over a hundred million pounds of margarine are used a month as a table spread, a tasty seasoning for hot vegetables and for many other purposes in cooking and baking. Included in the "Basic 7" food list, it serves as one of the finest and most concentrated energy foods. It is a shining example of a food which has been made repeatedly better.

In the original product which was invented more than 80 years ago, beef fats were used. Later these were replaced by lard and then by vegetable oils. When raw the latter, however, had several drawbacks: an unpleasant odor and taste, unsatisfactory color and a low melting point. These have been overcome by scientific refining methods, hydrogenation and use of certified food colors. Strictly phrased Federal Standards sponsored by the industry assure maintenance of very high quality, uniformity and nutritional value.

With this history of product improvement, it was natural that margarine makers would make their food a more valuable one by the addition of vitamin A. For over a decade many brands of table margarine were marketed with a label statement that they contained 9,000 International Units of vitamin A per pound. Now virtually all brands are fortified with vitamin A and the minimum amount supplied per pound is 15,000 I.U., an increase of over 66%.

Here are some of the benefits which vitamin A supplies. Scientific evidence is available showing that it helps to maintain normal vision and to overcome night blindness; that it increases the body's resistance to infections; that it promotes physical and mental development; and that it aids in maintaining normal glandular function.

Margarine makers who were accustomed to "fishy" odors and flavors when buying vitamin A sought a new source of supply. They found this new source in synthetic vitamin A—as produced by the famous synthesis evolved by the Roche research team headed by Dr. Otto Isler.

It was natural that margarine makers would adopt synthetic vitamin A for fortification of their products. When they were dependent on vitamin A extracted from fish liver sources, they found wide variations in vitamin A price. Synthetic vitamin A eliminated this disadvantage because its price is reasonable and stable. And a second disadvantage disappeared because synthetic vitamin A has absolutely no "fishy" odor, or taste, or after-taste!

Pure vitamin A and concentrates of it, produced by the Roche synthesis, have been approved by the Food and Drug Administration for use in margarine and other foods. It is light and clear in color.

Starting with citral, obtained from lemon grass oil, Roche vitamin A is built up through twelve manufacturing operations into a molecule identical with Nature's own.

At the huge Roche Park plant of Hoffmann-La Roche over 500 pieces of large-scale chemical engineering equipment in a multi-million dollar plant are working constantly to produce the superior Roche vitamin A.

Again, a development by the Roche people, who manufacture not only vitamin A but many other essential vitamins by the tons, has contributed to the making of a more nutritious food—and thus to the public welfare.

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# Affairs of the Institute

Editorial—On Coming of Age
News of the Regional Sections
Personnel
Recently Elected Members of the Institute
Books
Selected Abstracts
Annual Meeting Bulletin Board
Food Industry Topics
Future Dates

## On Coming of Age

J. A. DUNN
*Program Chairman, Thirteenth Annual Meeting (1953)*
Boston, Mass.

**Some reflections on annual meetings in general and on the thirteenth annual meeting in particular are furnished for this issue by the man who was too busy to do much reflecting at the eminently successful Boston meetings; namely, the 1953 program chairman, Avery Dunn. As the man who is expected to know everything from how to turn off the lights in the main assembly room to the main points to be covered at the all-day symposium on unsolved problems relating to the structure of unidentifiable proteinaceous substances—the program chairman's lot is sometimes "not an 'appy one."**

Perhaps you might wonder what the Program Chairman is thinking about, and worrying about, as the annual meeting of the Institute of Food Technologists gets underway. The success and acceptability of the program depends, among other things, upon anticipating what subjects the membership would like to have discussed; and since our members are interested in so many fields, the overall program must be very broad in coverage.

The founding fathers of IFT had in mind a forum where problems involved in the *processing of foods* and associated topics might be discussed and debated. It was *food technology* rather than *food research* that was uppermost in their minds when the two food conferences were called at the Massachusetts Institute of Technology, out of which came the birth of the Institute of Food Technologists. At that time, I understood, food research—particularly of the academic variety—was definitely of secondary consideration. At the Boston meeting, therefore, it was interesting and enlightening to your Program Chairman that not only a breakdown of the program time and the number of papers presented, but, what is more important, a tabulation of the *attendance at the various sessions* pointed unmistakably to the conclusion that research papers constitute a very important part of our program. This change has taken place over the past decade, and future program committees should keep this fact in mind. Because of the interest and pressure from the membership that more, rather than less, program time must be allotted for the presentation of research papers, this part of the program will take care of itself, provided that sufficient meeting rooms are made available adequate to hold those who wish to attend. Therefore it is more the responsibility of the Program Committee to develop the food technology sessions and special educational programs such as the symposium on Geriatrics at the Boston meeting.

The Institute has, in many ways, "come of age." A comparison of the attendance at the 1953 Annual Meeting with the previous Boston meeting, using the two M. I. T. conferences on food technology as a "bench mark," gives a very striking measure of our growth. Yes, we have grown as an organization and our maturity is becoming evident in a number of ways. As might be expected, our maturing has been attended with "growing pains." For example, it was strikingly evident at the Boston meeting that the Institute has outgrown the physical facilities of an average good hotel. We could have used considerably more space for the commercial exhibits and, as everyone knows, the sale of this space to exhibitors carries a substantial proportion of the expense of our annual meeting. The inadequacy of the meeting rooms was also strikingly evident. No program chairman likes to see people standing in the rear of the meeting rooms and out into the corridors. There is, however, some consolation in the fact that this is a condition more desirable than empty meeting rooms. At periodic intervals during the Boston meeting a spot check was made of the attendance at each of the concurrent sessions compared to the number of our members in the exhibit rooms and in the lobbies. The percentage attending the sessions was considerably larger than anticipated which is a striking illustration of the seriousness with which our members attend their annual meeting, and a definite indication of our maturity as an organization.

It was evident at the Boston meeting that there is much merit in a compact physical layout of the meeting. To have the meeting rooms, the exhibit rooms, the committee rooms, and the lobby close together is highly desirable and this fact was commented upon frequently by the members.

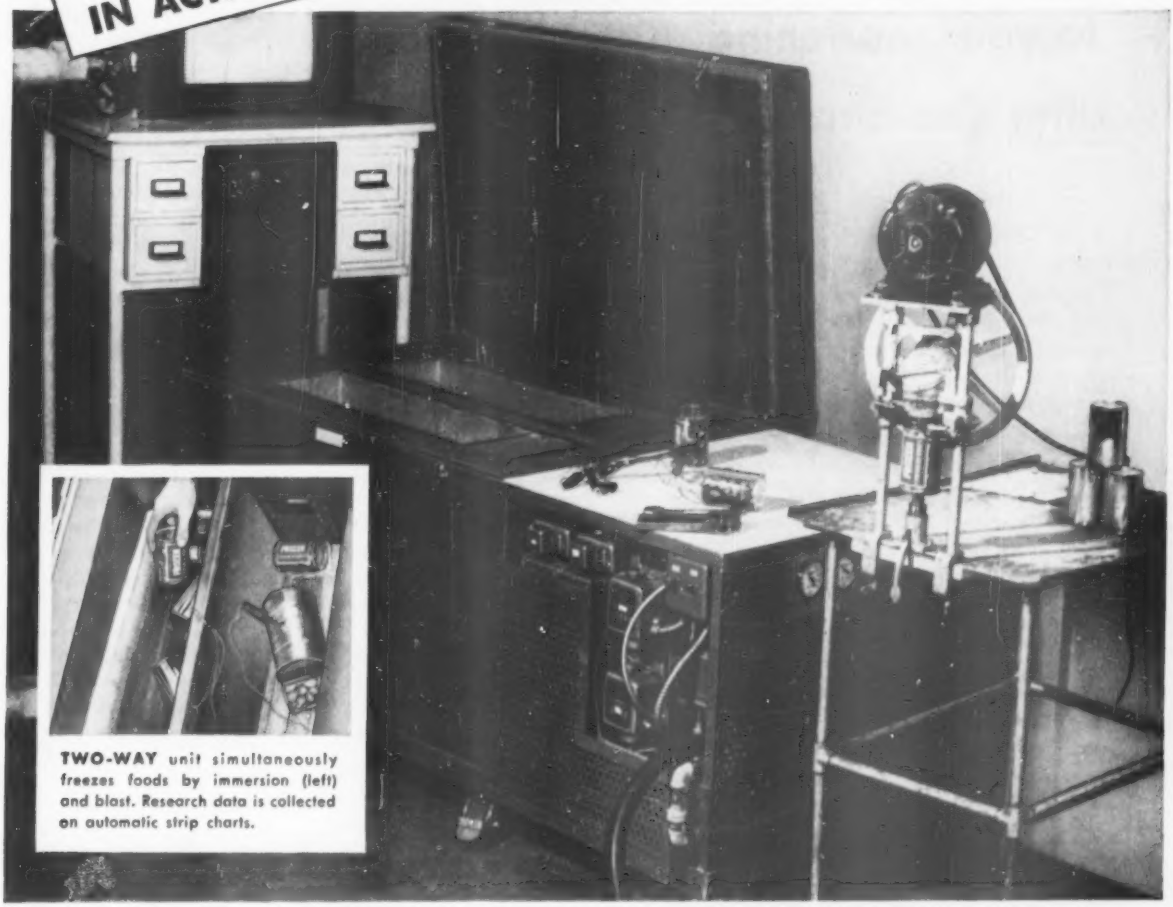
At our present stage of growth there are few locations in the United States where adequate exhibit space, adequate meeting rooms, and sufficient housing are available in one hotel. Thus we must now select the locations for our meetings primarily for the physical accommodations available rather than select a location which is a natural membership center, or where a local section is organized. For example, Detroit might have been a better location for an annual meeting, but Grand Rapids was selected because of its superior physical accommodations. Similarly, Cincinnati might be a better location from the standpoint of membership and accessibility, but Columbus can offer better physical accommodations.

This situation would be considerably alleviated were it not for the necessity to provide adequate space for the commercial exhibits. To have these exhibits housed in another building, even though close by, does not seem as satisfactory to the exhibitors as when we house them in the hotel. The cost of installing and erecting the exhibits is usually very high because frequently overtime wage rates apply because the exhibits must be installed over the weekend. One exhibitor made a suggestion to your Program Chairman which might prove to be a way out of the situation. If it were desirable,

(Continued on page 8)

*Continental*
**RESEARCH IN ACTION**

# New portable laboratory speeds answers to freezers' problems



**TWO-WAY** unit simultaneously freezes foods by immersion (left) and blast. Research data is collected on automatic strip charts.

**LAB EQUIPMENT** includes a recording potentiometer, thermocouples, 2-way freezing unit, and atmospheric and gas-vacuum closing machines.

In the interest of its can-using customers, Continental has long maintained 17 field research laboratories throughout the U. S. Now it has an "18th"—a compact, portable laboratory which travels right into the plants of frozen food packers.

Quickly set up in 48 square feet of space, it carries out in miniature the packaging and freezing operations of a full-size freezing plant. Whether the product to be packed is a fruit, a vegetable or a seafood, the portable laboratory will help pick the best freezing time, the best size and shape of can to use, and the best packing procedure – air closure, vacuum or gas pack.

Continental's portable laboratory was designed and built by its own scientists and engineers. It has already proved its worth by helping several of our customers in widely separated sections of the country to produce better products at lower cost... and in helping Continental produce tailor-made containers for a fast-growing industry.

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*is a division of* **Eastman Kodak Company**


### On Coming of Age

(Continued from page 6)

those firms now exhibiting might become sponsors of the annual meeting and, for a nominal fee, they might be permitted to engage a suite in the hotel. A list of these sponsors and their suite numbers would be prominently displayed. Exhibitors might find such an arrangement just as effective in reaching the membership as their displays have been in the past. Whether such a scheme is practicable might be ascertained by the Institute.

The foregoing suggestion might conceivably appeal to some of our regular exhibitors but might not appeal to those who wish to display heavy machinery, equipment, etc. It is conceivably a way out of our dilemma, but is not necessarily *the* way out. Sooner or later we may have to face the question—which is more important to our members, the exhibits or adequate meeting rooms?

In retrospect, I have been once more impressed with the salutory effect on a local section resulting from the responsibility of handling an annual meeting. There is no question but that the work and the responsibility leaves a local section much more closely knit and much stronger. Some organizations turn over the handling of their annual meetings to their executive secretary and central staff and, in some instances, decide upon one location where their meetings are held year after year. A casual appraisal of the strength of a local section before and after sponsoring an annual meeting can lead to but one conclusion, namely that for the good of our organization as a whole—which is a summation of its various sections—there is much to be said in favor of our present method.

## Regional Section News

### PITTSBURGH SECTION

The Pittsburgh Section held its 16th official meeting, its second meeting of the 1953-54 year, on December 8, 1953 at the Royal York Dining Room. The meeting was very well attended. Everyone enjoyed a well illustrated talk by Dr. G. P. Whitlock of the General Sales Department of Merck & Company. Dr. Whitlock's most interesting and informative discussion on statistics was titled "Figures—Facts or Fancy." Everyone who attended felt that this meeting was one of the finest ever held by our local section.

Our program for the balance of the year is now complete. Dr. Henry Smyth will discuss "Chemicals and Food" at the February 9, 1954 meeting. On April 12, 1954 Mr. Art Diamond will give a talk on the "Introduction of a New Food Product." For our Annual meeting to be held on May 11, 1954 we will hear Dr. H. Schreinber on "The Use of High-Energy Cathode Ray Sterilization."

One of the highlights of this meeting was the presentation to Dr. Fred C. Blanck of an engraved gavel from the National Society. At the last Annual Meeting, the Council of the Institute decided that each Past President

(Continued on page 10)

*Notes from the makers of*
**Myvax Vitamin A**

# What will she do with **vitamin A aldehyde?**

Actually, vitamin A aldehyde is a good source of vitamin A; it is readily absorbed and converted into vitamin A alcohol by normal human beings. But, so are Myvax Vitamin A Acetate and Palmitate, with which our customers are well satisfied.

Recently, vitamin A aldehyde became of interest in a rather unusual way. It seems that even though children suffering from fibrocystic disease of the pancreas can't benefit much from vitamin A acetate, they *can* use the aldehyde, which they readily convert into the alcohol form. Children with celiac disease, on the other hand, show poor utilization of *all* forms of vitamin A. Thus, vitamin A blood-level measurements provide physicians with a new technique for a differential diagnosis of these two diseases.

That we were called upon to supply the vitamin A aldehyde needed in these experiments is not unusual. We're constantly engaged in research in all phases of vitamin A activity and molecular structure.

To help increase man's knowledge of vitamin A is one of our obligations. The other is to serve commercial users promptly and conveniently with Myvax Vitamin A Acetate or Palmitate in bulk or packaged to individual batch requirements of margarine manufacturers as Myvapack Vitamin A. ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies and Company, Los Angeles and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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**more than 3500 Eastman Organic Chemicals for science and industry**

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## REGIONAL SECTION NEWS

(Continued from page 8)

of the Institute of Food Technologists be given a suitably engraved gavel to serve as a memento of his term in office as National President and as an expression of appreciation for his services to the Institute. Besides being a founder member of the Institute of Food Technologists, Dr. Blanck was president of the Institute in 1945.

Dr. Fred C. Blanck has had a wide and varied career in Food Technology. Near the end of 1952 Dr. Blanck retired as Administrative Fellow in charge of the Multiple Fellowship on Food Varieties of H. J. Heinz Company at the Mellon Institute. He had joined Mellon Institute in January 1947, following seven years of experience as chief research chemist for H. J. Heinz Co. Dr. Blanck has a wealth of specialized knowledge of almost every phase of scientific food work. His accomplishments in the successful development of research to its practical application, his experience in organizing and supervising investigational projects, his wide contacts with food research leaders throughout the world have made his name an important one in the food field. In 1947 Dr. Blanck was the first recipient of the Babcock Award of the Institute of Food Technologists, sponsored by the Nutrition Foundation for meritorious work in the food field related to public health.

It was a great honor for the Pittsburgh Section to be able to present the Past President Gavel to Dr. Blanck. Everyone was deeply moved when, after accepting the gavel, Dr. Blanck in turn presented it to the Pittsburgh Section to be used as an official gavel in all future sectional meetings. The Section will remember Dr. Blanck as long as it is in existence—for his remembrance to the local section, for all the fine work he has done for the National Society, and for his lifetime of work in the field of Food Technology.

### OHIO VALLEY SECTION

The Fall Meeting of the Section was held November 21 in Cincinnati, Ohio, at the Sheraton-Gibson Hotel. Dr. A. R. Winter, Chairman, presided at a joint meeting of the Executive Committee and the 1955 National Convention Committee. A. J. Glazier was in charge of registration.

A challenging program arranged for the afternoon by Dr. G. F. Garnatz, Vice Chairman, consisted of the following five papers with H. J. Alleman presiding:

"Extraneous Materials in Spices; Mold and Rot in Tomato Catsup"—T. McCormack, The Kroger Food Foundation.

"Preservation of Shell Egg Quality by Thermo-stabilization"—Patricia Shields, School of Home Economics and Dept. of Poultry Science, The Ohio State University.

"Automation of Production; Its Implications for the Future"—David Osborne, The Kroger Food Foundation.

"Can Production; An Example of the Application of the Principles of Streamlining"—J. Tevis Crutchfield, The Frank Tea and Spice Company.

"Food Frying Embodies the Elements of Continuous Processing, Heat Transfer and Incorporation of Fat"—C. J. Robertson, Procter and Gamble Company.

A brief business meeting was held at the close of the afternoon program.

Dinner for the Section members and their guests was served in the hotel. N. H. Volle introduced the speaker of the evening, Dr. Clarence A. Mills of Reflecto-Therm, Inc. and Professor of Experimental Medicine at the University of Cincinnati. Dr. Mills discussed the effect of climate on the behavior and accomplishments of man. He described in an exceedingly interesting manner his experimentation in heat transfer and space heating by radiation and reflectance. Many questions pertaining to applications in food technology were directed to the speaker.

### CHICAGO SECTION

Over 140 persons attended the annual Ladies' Nite program of the Chicago section, held December 14 in the Palmer House. Before dining, a social hour was enjoyed in which the cocktails were furnished by 31 suppliers in the Chicago area.

Mrs. Beth Bailey McLean, director of Home Economics, Swift & Co., kept the crowd in a jovial mood with her "Whim-sey Report." She reminded the food technologists of the role of the home economist in preparing a product prior to its initial sales promotion. Her department, which includes 25 graduate home economists in six cities, works closely with the Swift Research Laboratories. The program also included carol singing and drawing for door prizes.

Election results for the coming year were announced as follows:

Chairman—Stanley F. Brockington, Quaker Oats Co.

Vice Chairman—John M. Jackson, American Can Co.

Secretary—Lloyd Slater, *Food Engineering*.

Treasurer—Robert H. Maher, Swift & Co.

Executive Committee—George W. Beach, Libby, McNeill & Libby, Charles M. Wilson, Borden Co.

Counselors—Margaret Ives, American Can Co.—Robert G. Tischer, QM Food & Container Institute.

This report was submitted by the Tellers' Committee, consisting of Ernest Nordlinger, *Food Processing*, chairman; Mrs. M. M. Rolle, Vegetable Juices, Inc.; George F. Foss, White Cap Co.

### OREGON SECTION

On December 4, 1953 the Section met at the Swift & Co., North Portland, Oregon.

The program began with a tour of the meat packing plant. It was followed by an informal discussion of Swift's operations and products. Officers of the Swift & Co. participating in the discussion were Mr. C. Prichard, plant manager, Mr. E. G. Vondra, superintendent, and Mr. D. W. Turnham, chief chemist.

The program was followed by a business meeting.

### MARYLAND SECTION

The Section's December meeting was held at the Stafford Hotel, Baltimore, Md. on Friday, December 11, 1953.

Fifty-nine members and guests were present. Door

(Continued on page 14)

# TEN REASONS WHY...

## TYGON TUBING IS A BETTER PIPING MEDIUM IN FOOD PROCESSING

Here are ten reasons why you should use TYGON TUBING to transmit fluid foods, or beverages, in your plant:

1. **TYGON TUBING** is glass clear—provides full solution visibility — permits close flow control.
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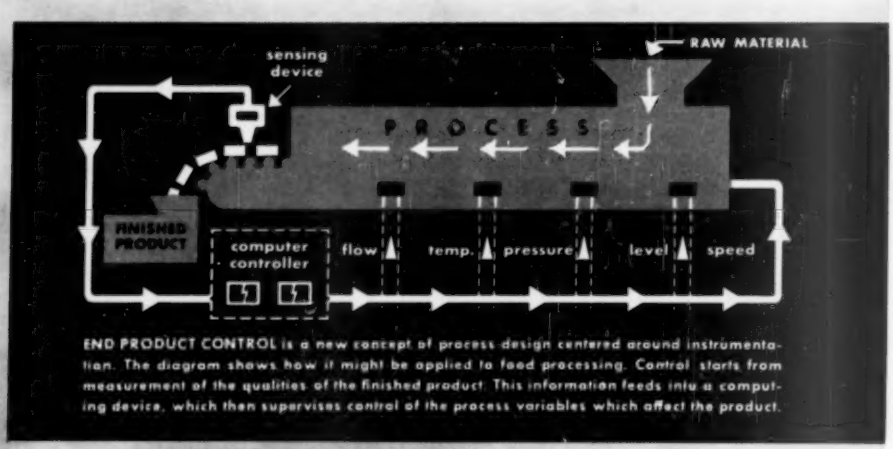
# In the food plant




**END PRODUCT CONTROL** is a new concept of process design centered around instrumentation. The diagram shows how it might be applied to food processing. Control starts from measurement of the qualities of the finished product. This information feeds into a computing device, which then supervises control of the process variables which affect the product.

# of tomorrow–

## *Honeywell instrumentation will implement new processing techniques*

THE RAPIDLY expanding technology of the food industry has already marked notable milestones in processing which help to point the course of the industry's future. And in many of these, instrumentation by Honeywell has played an important part.

The concentration and freezing of citrus juices, aseptic canning, and automatic cream neutralization are but a few of the many examples of developments which advanced instrumentation has helped to make possible. Today, scores of food processes produce more . . . produce better . . . because they are controlled accurately and automatically.

***What of tomorrow?***

New processes, new plants, new foods . . . all will be aided by the contributions of instrumentation, to an ever-increasing extent. For instrumentation offers limitless possibilities for the food industry . . . possibilities whose surface has yet been hardly scratched.

Today, for example, measurement and control are indirectly related to the product; they deal with temperatures, pressures and other variables which affect the process. Tomorrow may see the growth of Honeywell control systems which taste the flavor of the finished product, inspect its color, feel its texture, or evaluate its bacteriological purity. These systems, which may involve wholly new concepts of instrumentation, could then regulate the food processing equipment so as to produce the desired measured qualities in the end product.

This is but one facet of the role of instrumentation in the future of food processing. There are countless others . . . bold strokes of imagination today, but solid reality tomorrow . . . which Honeywell will explore in cooperation with forward-looking food technologists.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4502 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA:** For a challenging discussion of the future role of instrumentation, write for your copy of a paper entitled "How Automatic Can We Get?"

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

*First in Controls*

*Food plant design by The Austin Company anticipates new demands of the future.*

## REGIONAL SECTION NEWS

(Continued from page 10)

prizes were provided for both the ladies and the gentlemen in attendance.

New officers for the Section were elected as follows:

Chairman—Dr. Arthur Kaplan.
Vice Chairman—LeRoy V. Strasburger.
Secretary—William Lamble, Jr.
Treasurer—William Feild.
Councilors—Edgar G. Heyl and Albin Warth.
Executive Committee—Leonard Geiseker.

Mr. Heyl, as retiring Chairman, followed the usual custom of addressing the meeting. He spoke on "Food Fads" giving a scholarly resume of the activities of leaders in the field. It was a most interesting presentation and thoroughly enjoyed by the members.

## NORTHEAST SECTION

The Northeast Section of the Institute of Food Technologists honored, at their December meeting, three of their members who have been past presidents of the National society. At the meeting held at the M. I. T. Faculty Club on Thursday evening, December 3, Dr. Berton Clark, president of the Institute of Food Technologists, (3rd from left), presented gavels to Dr. Samuel Cate Prescott, emeritus professor of Industrial Biology at M. I. T. (2nd from left); Dr. Bernard E. Proctor, head of the Department of Food Technology at M. I. T. (at left); and Dr. Carl R. Fellers, head of the Food Technology Department, University of Massachusetts (at right). Each has made outstanding contributions in the field of food technology.

**Left to right—Dr. B. E. Proctor, Dr. S. C. Prescott, Dr. Berton Clark, Dr. Carl R. Fellers.**

Speaker for the evening was Henry F. McKenna, Jr., of the Employers' Group Insurance Companies, Boston, who addressed the group on "The Responsibilities of the Food Industries to the Consumer." Mr. McKenna is a member of the Massachusetts Bar, and is active in many professional societies in his field. The December meeting of the Northeast Section was the annual ladies' night. Among the distinguished guests were Mrs. Philip Bates of Los Angeles and Mrs. Berton Clark of Chicago.

## Recently Elected Members of the Institute of Food Technologists

Frank G. Alster
4644 Norma Drive
Pittsburgh, 36, Penna.

Earl J. Benjamin
438 Manhattan Ave.
New York 26, N. Y.

Garland R. Brown
Hercules Powder Co., Expt. Sta.
Wilmington, Dela.

William R. Channell
145 Mauna Loa Dr.
Monrovia, Calif.

William P. Clinton
521 E. 14th St.
New York 9, N. Y.

Abraham J. Cohen
Standard Can Co.
855 California Avenue
Pittsburgh 12, Pa.

Jerry Di Genova
3046 Eastchester Rd.
Bronx 69, N. Y.

John J. Fitzmorris
612 Sheridan Rd.
Evanston, Ill.

Dr. Herbert G. Foster, Jr.
Swift & Co. Res. Labs.
U. S. Yards
Chicago 9, Ill.

George Franck
99-19 66th Rd.
Forest Hills, N. Y.

Dr. Dean R. Frazeur, Sr.
Swift & Co. Ice Cream Res. Div.
U. S. Yards
Chicago 9, Ill.

Harold P. Hamilton
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Gloucester, Mass.

Clarence G. Hatmaker
Box 12-0, R. No. 1
Springfield, Va.

Peter Heiman
228 W. Broadway
New York 13, N. Y.

Charles A. Hoover
Anchor Hocking Glass Corp.
Plt. 35, Pkg. Eng., W. Fair Ave.
Lancaster, Ohio

John K. Hore
Lever Bros. Pty. Ltd.
Reynolds St.
Balmain, N.S.W., Australia

Seymour R. Jacobson
Wyler & Co.
1050 W. Fullerton
Chicago 14, Ill.

Herman K. Jones
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Summer Hill
Sydney, N.S.W., Australia

Frank P. Mainer
196 Bard Ave.
Staten Island 2, N. Y.

Harold Markman
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Philadelphia 18, Pa.

Olavi Elis Nikkila
J. Herttuan Puistotie 10
Turku, Finland

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Brooklyn 10, N. Y.

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Kenneth F. Shaw
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Leamington, Ont., Canada

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3506 Vega Ave. corner Fulton Rd.
Cleveland 13, Ohio

John C. Weinrich
520 Woodside Dr.
Woodside, Calif.

Gene A. Wozny
923 So. Harrison St.
Park Ridge, Ill.

### STUDENTS

Esam E. M. Ahmed
Hort. Dept. Uni. of Md.
College Park, Md.

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Food Technology Dept.
Corvallis, Ore.

Augustin F. Bartik
Oregon State College
Food Technology Dept.
Corvallis, Ore.

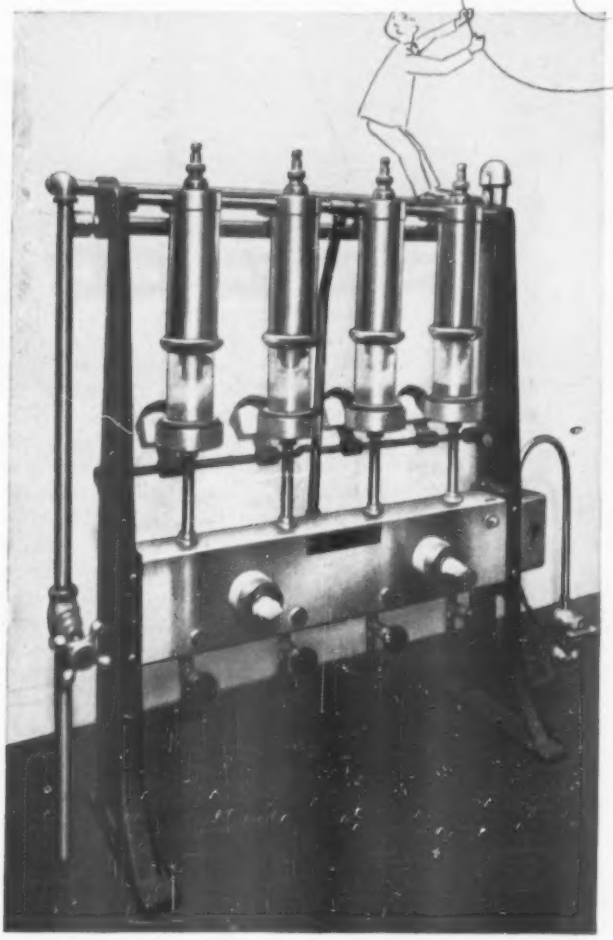
Charles E. Farris
Theta Xi
Corvallis, Ore.

Allan J. Olson
Sigma Alpha Epsilon
Oregon State College
Corvallis, Oregon

(Continued on page 16)

# How Griffith's Extraction Process Assures Better-Flavored Products

## PEPPEROYAL AND SOLUBLIZED SEASONINGS



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In this age of scientific miracles, Griffith's staff of chemists enables you to change a good product into a delicacy—simply by changing to PEPPEROYAL or SOLUBLIZED SEASONINGS.

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## RECENTLY ELECTED MEMBERS OF THE INSTITUTE OF FOOD TECHNOLOGISTS

(Continued from page 14)

Robert L. Parker
414 Pinehurst Ave.
Salisbury, Md.

Paul J. Riddle, III
957 Jefferson
Corvallis, Ore.

E. William Reynolds, Jr.
535 S. East Ave.
Oak Park, Ill.

Lawrence W. Scott
644 S. 18th
Corvallis, Ore.

## HONORARY SOCIETY FOR FOOD TECHNOLOGISTS FOUNDED

History was made in Amherst, Massachusetts on December 1, when an honorary Food Technology society was founded by a group at the University of Massachusetts. The organization, which is to be known as "Phi Tau Sigma, Honorary Society," will be incorporated under the statutes of the Commonwealth of Massachusetts, with headquarters remaining at the University. It is intended that charters will be granted for the establishment of local chapters in other areas in accordance with the procedures promulgated in the Constitution of the Society.

The purposes of the organization are to "encourage the application of fundamental science to Food Technology, to honor and recognize achievements in the field and to promote fellowship, thereby stimulating the free exchange of knowledge in Food Technology." These goals will be carried out through an active program of scientific lectures, discussion meetings and social gatherings by chapters as well as the election to membership of qualified Food Technologists and advanced students of Food Technology.

Elected to the Board of Directors of the Society were: Milton P. Baldauf, Robert V. Decareau, Enio Feliciotti, Gideon E. Livingston, William D. Powrie, Maynard A. Steinberg and Donald E. Westcott. Dr. Gideon E. Livingston, Associate Research Professor of Food Technology, was elected Chairman of the Board of Directors and President of the Society for 1954. Mr. William D. Powrie, Research Instructor in Food Technology, was elected Vice-President; Mr. Enio Feliciotti, Instructor in Food Technology, is Secretary-Treasurer of the Society, and Mr. Donald E. Westcott, Instructor in Food Technology, was appointed Executive Secretary of the organization.

In recognition of his numerous contributions to the profession of food technology as an inspiring teacher, a tireless research scientist, and distinguished officer of the United States Army Reserve Corps, Dr. Carl R. Fellers, Head of the Department of Food Technology at the University of Massachusetts, was elected Honorary President of the Society at the first meeting of its National Council. In addition to his many other honors, including the Institute of Food Technologists' Babcock Award and the Army's Distinguished Service Medal, Dr. Fellers is a director of the Associates, Food and Container Institute, a past president of the American Public Health Society, of the Institute of Food Technologists, and of the American Chemical Society's Agricultural and Food Division.

## Books

Cocoa, Volume 3, *Economic Crops.* Edited by Eileen M. Chatt, 302 pages, xii, Interscience Publishers, Inc., New York and London.

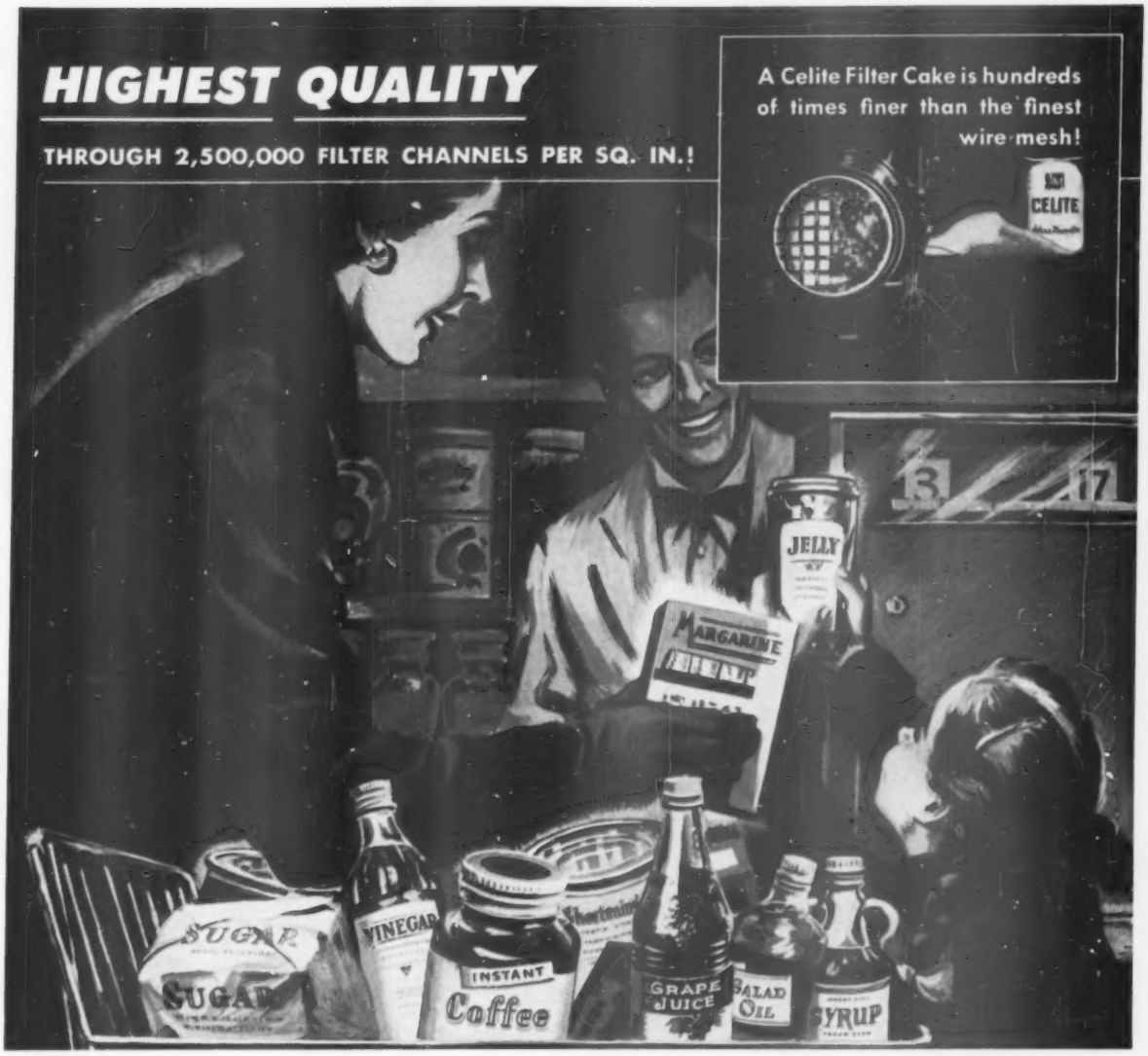
This is the fourth of a series of monograms on the chemistry, physiology, and technology of food products. The present volume relates to the cultivation, processing, and analysis of cocoa. The modest title of the book, *Cocoa,* could be misleading in that, actually, unlike the products described in the two previous volumes of the series—i.e., apples and bananas—the cocoa bean is a product which must pass through intricate technological processes in order to change from its original form to become chocolate liquor, cocoa butter, or cocoa—which are only the starting points of many food items in the cocoa and chocolate industry.

The contents of the book are, however, inclusive. The first six chapters deal with the history, botany, cultivation, diseases, and the fermenting and drying of the cocoa bean. The next three chapters describe the manufacture of chocolate liquor, cocoa butter, cocoa powder, and chocolate. The remaining three chapters are concerned, respectively, with the nutritional value of cocoa products, methods of analysis, and the cocoa and chocolate industry in summary.

The book, *Cocoa,* will be well received by food technologists whose products require either chocolate liquor or cocoa powder in their manufacture. There are, it must be said, a few limitations. The author has cited most of the recent articles published on cocoa and chocolate, but many of the research papers referred to have been accorded only a few sentences. In many cases this brief treatment has not fully revealed the meaning of the author's contribution. Apparently the author in practicing the virtue of brevity tried to condense this book into too small a treatise.

There is definitely a need for an up-to-date book of this nature, and this reviewer predicts that it will go through more than one edition. When and if a new edition is contemplated, the author may wish to consult the reports of the National Confectioners Association, the American Association of Candy Technologists, the Pennsylvania Confectioners Association, and the Quartermaster Food and Container Institute for the Armed Forces for useful new findings. These four organizations are conducting much research and development work on cocoa and chocolate products. Such information will help to keep the book current with respect to the newer research and development trends now becoming evident in the United States. There are no doubt similar research organizations at work in countries overseas and these should also be consulted. But turning from thoughts for a future revision to the book in hand, candy and chocolate technologists will find this volume a *must* for their reference shelves. Since the United States is the world's largest consumer of cocoa beans, technical information on this important product should be more accessible. This book is a step in the right direction.

Justin J. Alikonis,
Bloomington, Illinois.

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The Celite method is *efficient.* It removes even the finest suspended solids. Moreover, Celite Filtration is *economical.* It may be used with any type of conventional filter, it is almost automatic, and skilled labor is not required for routine operation. And Celite Filtration is *flexible.* To meet your specific requirements, Celite comes in nine standard grades of microscopically controlled particle size. The right balance between degree of clarity and rate of flow may be easily controlled.

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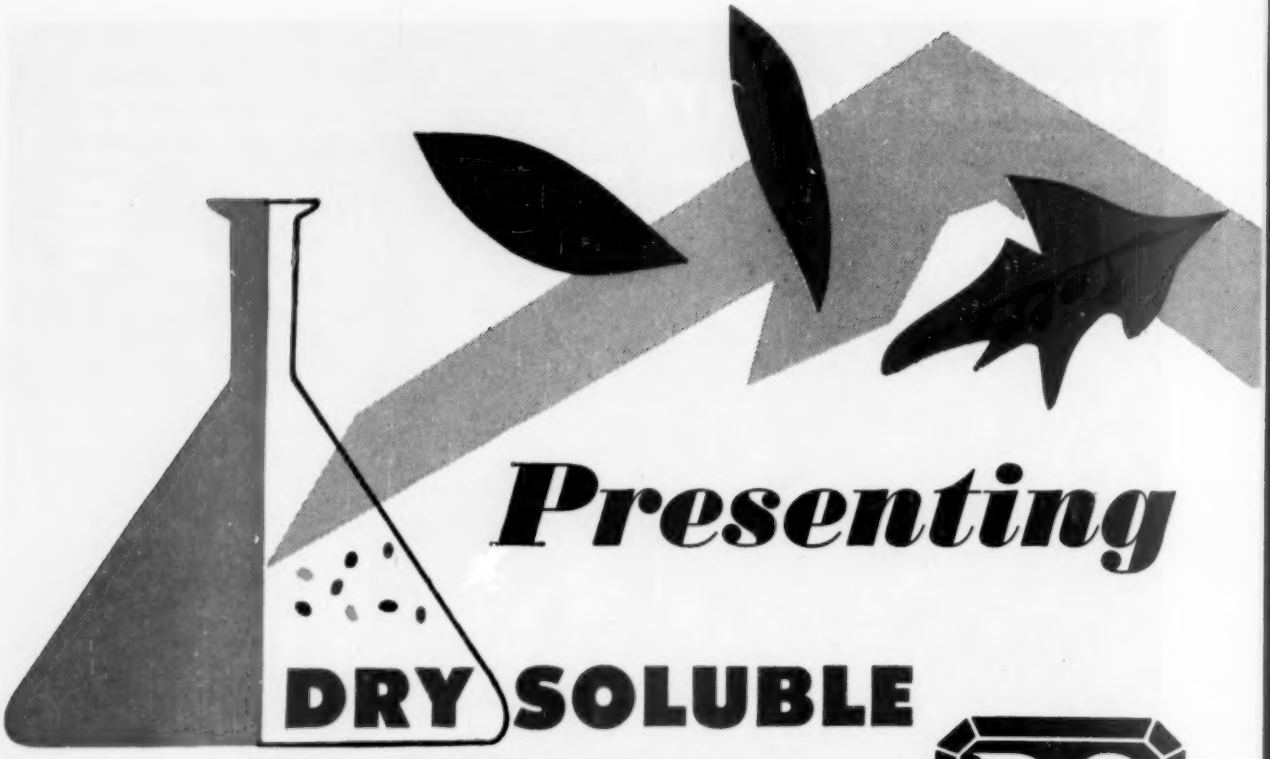

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***For more than 155 years***

Dodge & Olcott, Inc. has supplied to various segments of the food industry, flavoring materials of unsurpassed excellence. D&O essential oils, oleoresins, and specialty flavor lines are known and respected throughout the trade and D&O's reputation for integrity, service and experience are unexcelled. Now, as a further service to the food processing industry, D&O presents its newest development...a complete line of *DRY SOLUBLE SEASONINGS.*

***A special factory***

has been built for the manufacture of this new line, complete with *all stainless steel equipment.* No metal contamination can occur... no dust or residual odors will be found. D&O Dry Soluble Seasonings are pre-packaged in batch lots per individual requirements and shipped in containers most suitable for particular item involved.

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### *Tailor-made formulations*

Basic formulations for all the most popular prepared meats, soups, pickles, dressings, and related food products are available to manufacturers to be used as a starting point for developing their own particular flavors. Infinite variations are possible and will be worked out in the D&O Flavor Labs to meet the exact requirements of each processor.

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D&O Dry Soluble Seasonings are made from 100% natural oils or oleoresins . . . all extractions and adjuncts are prepared with the finest raw materials obtained through the company's extensive international sources.

### *Guaranteed uniformity!*

A complex quality control system insures consistent high quality, and individual technical service is available to food processors with specific problems in flavor development and control. Contact the D&O representative in your district or write for details on the latest D&O service to the food industry . . . *D&O DRY SOLUBLE SEASONINGS.*

**. . the Leadership Line of Dry Solubles**

**Founded in 1798**

# Selected Abstracts*

## ANALYTICAL METHODS

**Determination of D-glucose in corn sirups.**

WHISTLER, R. L., HOUGH, L., AND HYLIN, J. W. *Anal. Chem., 25,* 1215-16 (1953).

Glucose dehydrogenase is used for the direct stoichiometric detn. of D-glucose in a variety of corn sirups. In the presence of $O_2$ the enzyme oxidizes D-glucose to D-gluconolactone, which is detd. quantitatively by titration with standard alkali.

**Turbidimetric determination of a modified gelatin in biologic materials.**

ROGERS, C. J. *Am. J. Clin Pathol., 23,* 638-44 (1953).

A turbidimetric procedure for the detn. of oxypolygelatin, utilizing trichloroacetic acid to sep. gelatin from other proteins is described. Evaluation and comparison of this method with other methods indicate the advantages of this procedure for routine use. The technic described was applied to analyses for gelatin in blood plasma, urine, gastric juice, ascitic fluid, and liver tissue.

## BIOLOGICAL SCIENCES

### BIOCHEMISTRY

**Find linoleic acid aids radiation protection.**

*Science News Letter, 64,* 5 (1953).

A certain level of linoleic acid is necessary to protect animals from radiation damage. Amts. of the fatty acid above this level, however, seem to contribute to the destruction of vitamins and certain other essential tissue constituents during radiation exposure.

**The chemistry of biological after-effects of ultra-violet and ionizing radiations.**

*Discussions Faraday Soc., 49,* 323-44 (1953).

A synopsis of 16 papers on the subject.

### BOTANY AND AGRICULTURAL CHEMISTRY

**Greater effects from growth modifiers.**

*Agr. Research, 2,* 15, August, 1953.

Boron steps up the translocation of common table sugar adsorbed by the leaves of bean and tomato plants. This knowledge can be applied to speeding up the movement of 2,4-D and other growth modifiers through plants.

### MICROBIOLOGY

**An electrophoretic method for the assay of bacterial variants.**

HARTMAN, R. S., EIGELSBACH, H. T., BATEMAN, J. B., BRAUN, W., HERRING, R., AND RODGERS, R. U. *Appl. Microbiology, 1,* 178-83 (1953).

If 2 variants of a given strain differ in their surface charge characteristics, it is possible to det. the frequency of each variant in a mixed population by the microscope method of electrophoresis. This method is both rapid and simple. Statistical analysis of the results of 44 assays of mixed populations of *Pasteurella tularensis* showed that the estn. of the percentage of variants by this method did not differ significantly from that of the more common method of inspection and counting of the colonial types developed on a solid medium.

### NUTRITION

**The biological availability of heated wheat gluten-glucose mixtures.**

HALVEY, S., AND GUGGENHEIM, K. *Arch. Biochem. Biophys., 44,* 211-17 (1953).

Autoclaving gluten in the presence of glucose impairs the liberation of amino N by digestion with pancreatin. Autoclaving of the gluten-glucose mixt. leads to a partial disintegration of some of the essential amino acids. This loss amts. to 83% for arginine and to 50% for lysine. *In vitro* digestibility studies with pancreatin showed a diminished liberation from the complex of most of the essential amino acids, particularly of lysine, histidine, threonine, and arginine. Autoclaving gluten with glucose reduces significantly its digestibility as well as its biol. value for rats. Supplementation of the complex with lysine, or with lysine and arginine, restores the biol. value to that of gluten heated without glucose.

**The nutritive value of coconut toddy.**

LEONG, P. C. *Brit. J. Nutrition, 7,* 253-9 (1953).

Coconut toddy was analyzed for ash, protein, fat, invert sugar, sucrose, acidity and alc. The distribution of thiamine, riboflavin, nicotinic acid, Ca and Fe between the suspended yeast cells and the fluid portion of coconut toddy was detd. The consumption of coconut toddy in moderate quantities would not make any significant contribution to the human requirements for thiamine, riboflavin and Ca. The amts. of nicotinic acid and ionizable Fe in the fluid portion of a pint of toddy (1.2 mg. and 1.3 mg., resp.) would furnish about 10% of the recommended daily allowance.

**Effect of dietary fat and cholesterol on the blood cholesterol level in rats.**

SWELL, L., AND FLICK, D. F. *Am. J. Physiol., 174,* 51-3 (1953).

Rats were fed diets contg. 25% lard, oleic acid, or stearic acid diets with and without cholesterol. The blood cholesterol rose sharply in both groups on the lard diets. The change occurred predominantly in the ester fraction. When oleic acid was added to the diets, the total and ester cholesterol of both groups declined slightly. On the stearic acid diets the total and ester cholesterol of both groups declined, but more sharply in the cholesterol group. It is suggested that incomplete absorption of cholesterol takes place when a high percentage of satd. fatty acid is present in the diet.

**Changes in body build and body composition during aging.**

*Nutrition Revs., 11,* 100-3 (1953).

The data indicate that many, and perhaps the majority, of morphologic features continue to change throughout the lifespan of an individual. The body compn. was characterized by means of skinfold measurements used as an index of subcutaneous fat, and of sp. gr. Nutritionally it is of interest that the increase in the fat fraction is faster than the increment in total body wt. The principal conclusion drawn from the data was the av. caloric intake during maturity tends to be larger than the actual caloric needs.

**The fabulous market for food.**

*Fortune, 48,* 135-9+, October, 1953.

With the use of graphs depicting food expenditures in billions of dollars, % of income spent on food, per capita expenditures on foods, the rise of processed foods, and vol. of different types of food bought in the U. S., the author proposes that the U. S. is not eating more but eating "better." Consumers especially demand convenience in their food purchases, which has brought great changes in food processing and in marketing technics.

### PHARMACOLOGY AND TOXICOLOGY

**Toxicity of boric acid and borates.**

*Chem. Week, 73,* 40, September 19, 1953.

FDA is collecting evidence to show that use of boric acid and sodium borate in baby powders can lead to severe toxic symptoms, wants to require that drug store products contg. these ingredients be labeled "poison."

(Continued on page 22)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

# ASCORBIC ACID MERCK

## Gives Your Products Point-of-Sale Appeal

If you market any of the food products listed below, note how MERCK ASCORBIC ACID can improve appearance, taste, or nutritional value. FRUIT JUICES can be fortified with Merck Ascorbic Acid to supply substantial amounts of Vitamin C at all times. FROZEN FRUITS protected against oxidation with Merck Ascorbic Acid look and taste better to flavor-conscious customers. MILK SUPPLEMENTS offer additional nutritional value when they include Merck Ascorbic Acid. FROZEN FISH, high in fat, get customer-appealing protection against rancidity and darkening when Merck Ascorbic Acid is the antioxidant.

## Other Merck Products for the Food Industry:

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*Research and Production for the Nation's Health*

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*Manufacturing Chemists*
RAHWAY, NEW JERSEY

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## SELECTED ABSTRACTS

(Continued from page 20)

**New approaches to the health hazard evaluation of pesticides.**

KINGSLEY, K. *Arch. Ind. Hyg. and Occupational Med., 8,* 70-5 (1953).

The aspects of pesticide hazard evaluation warranting more detailed study before new products are introduced to the market are indicated. Three new approaches are described and exemplified by exptl. work: (1) Toxicity of actual trade formulations should be detd. to take into account toxicity contribution by impurities and assocd. materials. (2) The health hazard evaluation of pesticides is a combination of toxicity and level of application. Field study of environmental exposure, clinical aspects, and biochem. response in the subclinical range would appear to be the soundest approach to such an evaluation. (3) Study of biochem. effects should be instituted when new products are developed, so that specific clinical tests and antagonizing agents may be available for the health protection of exposed persons.

### PHYSIOLOGY AND MEDICINE

**Action of insulin on transfer of sugars across cell barriers: chemical configuration of substances responsive to action of the hormone.**

GOLDSTEIN, M. S., HENRY, W. L., HUDDLESTUN, B., AND LEVINE, R. *Am. J. Pyhsiol., 173,* 207-11 (1953).

Sugars possessiong the same configuration as *d*-glucose at carbons 1, 2, and 3 are aided by insulin to enter certain cells. This is believed to strengthen the postulate that the physiol. action of insulin is to facilitate the transfer of glucose, as a free hexose, from the extracellular fluid to the intracellular space in certain organs and tissues.

**A simple method for taking blood samples from rats.**

KEPINOV, L. *J. physiol.* (Paris), *44,* 161-2 (1952); *Excerpta Med., 6,* 358, No. 1658 (1953).

The rat is placed in a tube electrically heated at 40° C.; the result is a vasodilatation extending also to the tail which hangs outside the tube. Blood taken from the tail is collected in small tubes, the walls of which are covered with a thin film of a 20% soln. of neutral K oxalate. In this way 6-8 samples of 0.3-0.4 ml. blood may be taken per day, or a single sample of 2-3 ml. The method is particularly useful for study of exptl. variations of blood sugar.

## ENGINEERING AND PLANT EQUIPMENT

**Instrumentation for pilot plants.**

*Ind. Eng. Chem., 45,* 1836-52 (1953).

A symposium contg. the following papers: Introduction, Berg. C. (1836-44); Recorders and controllers in pilot unit instrumentation, Roth, E. R., and Masologites, G. P. (1845-9); Specialized recorders and controllers on pilot units, McIntosh, C. H. (1849-52).

**Process design and specification of pumping equipment.**

JACKS, R. L. *Chem. Eng. Progr., 49,* 235-42 (1953).

A short discussion of the general types of pumps is given followed by design procedures for new installations. Several tables and charts are included. Two sample design problems illustrating the procedures discussed earlier are given.

**Performance of a pulse extraction column.**

COHEN, R. M., AND BEYER, G. H. *Chem. Eng. Progr., 49,* 279-86 (1953).

The effects of operating variables upon extn. efficiency and column capacity were investigated for a continuous countercurrent liquid-liquid extn. column contg. perforated plates operated with a pulsed liquid phase. Cyclic pulsations were imparted to the liquid in the column to produce counterflow of both phases through the plate perforations and to provide a high degree of dispersion and turbulence by the continuous formation of fresh interfacial surface.

## FOOD AND FOOD TECHNOLOGY

### CHEMICALS IN FOOD

**A review of chemicals in foods.**

KAPLAN, E. *Assoc. Food & Drug Officials U. S. Quart. Bull., 17,* 102-10 (1953).

A review of problems, research, and present status.

### FATS AND OILS

**Autoxidation of fats and oils. III. A new instance of first-order rate destruction of antioxidant during autoxidation of fats.**

KARTHA, A. R. S. *J. Sci. Ind. Research (India), 12B,* 37-8 (1953).

The antioxidant licorice root *(Glycyrrhiza glabra)* is destroyed according to the unimol. reaction rate as already reported for tocopherol.

### FEEDINGSTUFFS

**Some problems on feeding fats to dogs.**

CAMPBELL, J. E., AND PHILLIPS, P. H. *Southwestern Veterinarian, 175,* Winter, 1953.

Studies showed that young growing pups require no addnl. fat in their diets above that found in normal com. feeds. Further, diets which contain high levels of fat can be successfully used provided the protein level or the proper level of amino acids is maintained. The inclusion of 15 to 20% fat in the ration of the growing dog with limited exercise was sufficient to reduce daily food consumption appreciably, which resulted in a methionine level insufficient for growth. The addn. of methionine to the high fat diet (15% added fat) resulted in growth equal to that of the control pups fed the low or normal fat contg. ration. Thus a ration for dogs which contains added fat requires careful formulation of the amino acid compn. to meet the dogs' requirements, or it requires a higher level of good quality proteins to meet the dietary needs of the growing pup.

### LEGISLATION

**Factory inspection law.**

*Food, Drug, Cosmetic Law Repts., No. 125,* 1, September 21, 1953.

Prescription, formula, complaint, and personnel files are not within the scope of compulsory inspections according to a statement by FDA Commissioner Crawford. When there is a need or reason to examine such files inspectors may ask permission to see them and may state their reasons for the request but they will not otherwise press the owner, operator or agent for the necessary permission.

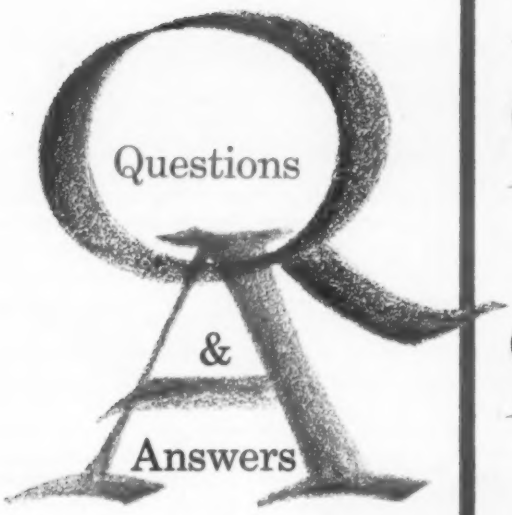
### PRESERVATION

**p-Hydroxybenzoic acid esters as preservatives. I. Uses, antibacterial and antifungal studies, properties and determination.**

AALTO, T. R., FIRMAN, M. C., AND RIGLER, N. E. *J. Am. Pharm. Assoc., Sci. Ed., 42,* 449-57 (1953).

The history of the esters of *p*-hydroxybenzoic acid and their uses as preservatives in a wide variety of pharmaceuticals, cosmetics, foods, and industrial products, and also in antimycotic therapy are traced briefly, with references to pertinent literature. An extensive description of the phys. and chem. properties of the *p*-hydroxybenzoates is given. Methods of incorporation are

(Continued on page 28 following technical papers)

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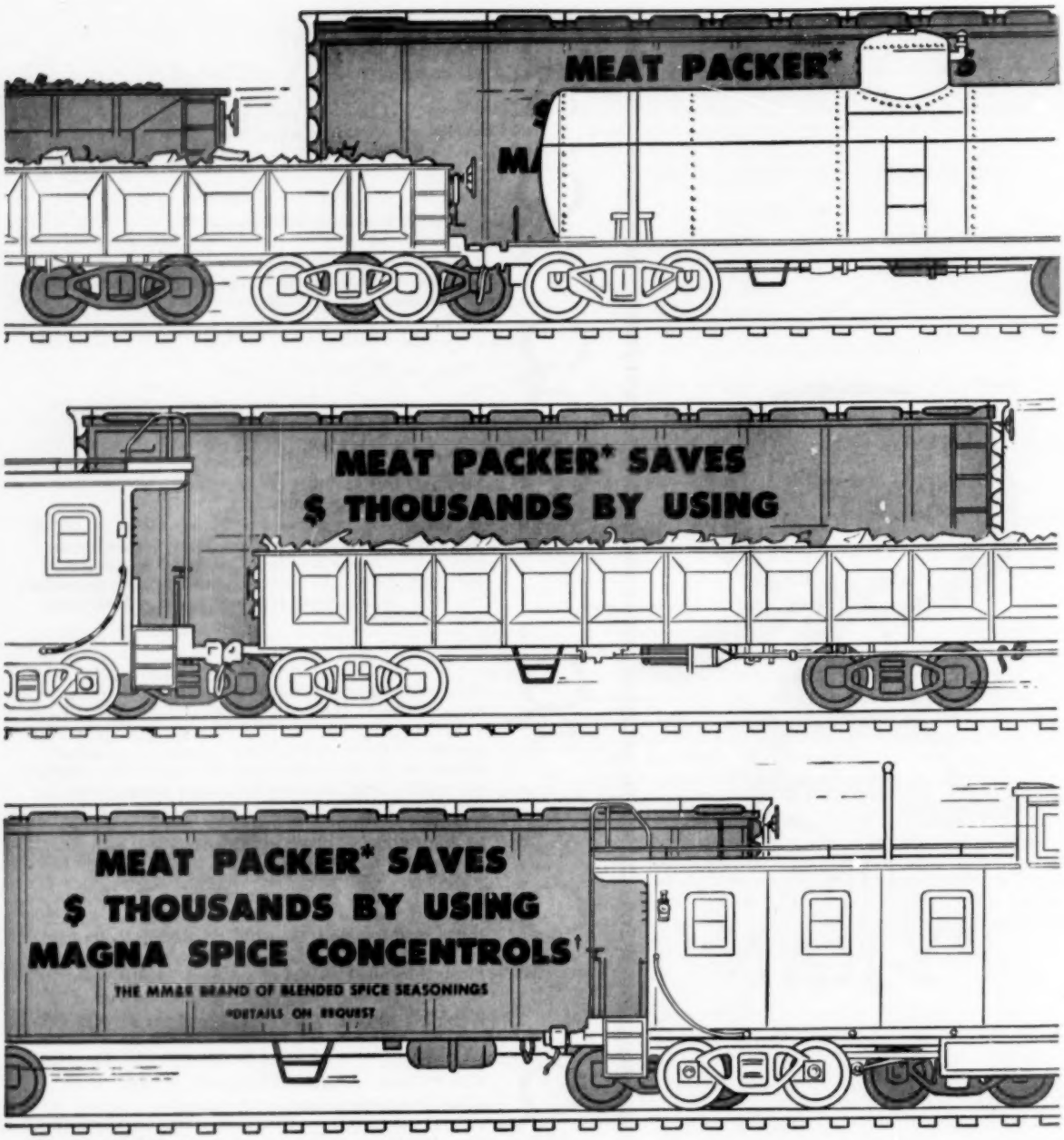


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# The Ocean as a Potential Source of World Food Supply[a]

GEORGE A. REAY
*Torry Research Station, Aberdeen, Scotland*

(Manuscript received September 18, 1953)

Since the War, there has been much discussion of sea food resources throughout a world that faces the enormous problem of feeding all its people at a desirably high nutritive level. In such discussion, the Food and Agriculture Organization of the United Nations has played a guiding and stimulating role; and the ocean as a provider of food received extended consideration in 1949 at the U. N. scientific conference on the Conservation and Utilisation of Resources. Inevitably, one draws upon the record of these meetings and upon various F. A. O. publications.

There are two main aspects of the subject: firstly, what is the potential food resource of the sea, and secondly, if we were able to come by it, how could we use this food to the best advantage? The extent to which we shall approach the potential limit will largely depend upon our techniques of preserving, transporting and distributing, and the possibilities of applying them economically.

**The basic productivity of the sea.** For ages, man has used sea food, and this food is there for the taking, however difficult in many cases. On the sea, man all the time reaps where he has not sown. Except for the cultivation of some shell-fishes and fresh water fishes, there is no practice of "aquiculture"; and it is doubtful in the extreme if this can ever be extended significantly to the ocean at large. For sea food man takes mainly fishes, mammals, molluscs and the larger crustacea. However, at the base of the food production pyramid there is the prodigious photosynthetic activity of microscopic floating plants—the phytoplankton. This supports first very small vegetarian marine animals—the zooplankton. On these, in turn, feed larger marine animals upon which the fishes feed, some species of which feed on others. The baleen or whalebone whales feed directly on zooplankton.

The primary production of organic matter occurs from 10 to 100 m. deep in the surface layers of the ocean which covers 70% of the earth. There has thus been much speculation about the superior productivity of the sea as compared with the land with its glaciers, mountains and deserts. The sea has been credited with as much as 90% of the world's primary production. Sverdrup, however, in the light of existing hydrographical and biological data, has recently put marine primary food production at about equal to that of the land.

Organic production in the sea varies much from region to region and during the year. It varies with light penetration which depends on transparency and latitude and with the supply of nutrient salts (e.g. phosphate and nitrate) to the surface. This supply is dependent upon particular horizontal and vertical water movements, which result in the best growth of plankton and, consequently, in that of higher animals. Nowhere is the surface completely sterile; but the great production occurs only in places where great exchange and mixing of water occurs.

In a three stage chain from phytoplankton to fish, the latter possibly represents only about 1/10,000 to 1/1,000 of the food value of the plants. It has been seriously asked, therefore, in recent years whether we could use plankton—at any rate zooplankton—directly as human food or as an animal feeding stuff. Whales certainly can do it. Baleen whales grow to lengths of about 70 feet in only two years from birth, entirely on a zooplankton diet. German scientists are reported to have found before the War that zooplankton has a nutritive value equivalent to that of the best meat and phytoplankton one equivalent to that of rye flour. The Chinese apparently use a sort of "shrimp" paste made from zooplankton as an accessory food for poor people. And, of course, the Kon-Tiki men reported that plankton was palatable and satisfied hunger.

The mere analyses of dried copepod zooplankton available look promising enough except for the presence of 5% chitin; but in a recent nutritional study by Clarke and Bishop, rats did not do at all well on raw or cooked copepod plankton alone or as a supplement. The research team who thought the plankton had a "mildly shrimpy flavour" and was "good" or "not objectionable," found that 30 to 40 g. (wet weight) produced the impression of remaining undigested in the stomach for several hours. Larger amounts were quite distasteful.

Clearly much more research is required to show if zooplankton, with or without special processing can be satisfactorily used as food by man or his farm animals. Apart from this, however, economic collection of the material is a formidable problem. Another difficulty, too, will be the avoidance of undesirable, for instance, poisonous types of organisms.

It would be extremely rash to bank upon plankton as a direct source of food for a long time to come, and, for the present, there is much to do in improving the exploitation of the traditional sea foods. Study of the sea's primary productivity will, however, continue to play its vital part in explaining natural fluctuations in the stocks of food fishes.

Let us exclude consideration of seaweeds—marine algae—as having no really significant food value, although they are, of course, eaten, notably in Japan. For the rest, let us consider the more normal sea foods, looking first at the mammals.

## MARINE MAMMALS

Seals merit no more than a passing reference. They are pursued mainly for their skins. Oil for industrial purposes is made from the blubber and the carcass and sometimes meal from the flesh. There appear to be no world estimates, but in its totality the potential yield of food for humans and animals from seal resources does not appear to be great.

[a] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 23, 1953.

On the other hand, whales and their relatives represent a really important asset. The main order, Cetacea, is divided into the *baleen* or *whalebone* whales and the *toothed* whales. The latter include the *sperm* whales, porpoises and dolphins. The baleen whales are now of outstanding commercial importance. Of these, the most important are the blue whale and the fin whale. In 1950, some 45,060 whales of all kinds, totalling some 2 million metric tons, were caught all over the world, but mainly in the Antarctic. Just about half were fin whales; about one-fifth, sperm whales; and about one-seventh, blue whales. Blue and fin whales thus accounted for 65% of the catch and for 79% of the baleen whales taken. These 2 species are larger than all the others. Blue whales average 80 feet in length and 87 tons in weight; fin whales, 69 feet and 52 tons. In 1951, 55,787 whales were caught all over the world, probably the highest catch ever made in 12 months.

In the Antarctic, waters rich in dissolved salts lead to a phenomenal growth of phytoplankton and then of zooplankton on which the baleen whales feed. The food chain is thus short and direct and probably nowhere else in the sea can man harvest an end product in greater quantity or in more concentrated form. However, from Professor Ruud's recent *Modern Whaling and its Products*, one must conclude that there is little hope of catching whales generally at a higher intensity than at present.

In the greatly preponderant Antarctic fishery, stocks have been protected by international agreements since 1937, and the regulation seems to have been on the whole successful. Since the War it has enabled the procurement of about the same amount of oil and the same quantity of whale substance per catching vessel's day's work as in 1938-39. Whale substance is expressed in an agreed common measure as "blue whale" units (approx. 80 ton). Ruud, however, sounds a warning note. To the biologist there are signs of a constantly shrinking blue whale stock; and the blue whale gives the highest yield of oil. The several times larger stock of fin whales will probably not sustain for long the present rate of catching. Average length is decreasing and percentage of immature animals caught is rising. A higher minimum length was introduced 2 seasons ago. With a lasting industry in mind, therefore, it is likely that some reduction in the permitted total catch will soon have to be made.

Here is a stock, then, not likely to expand but under fairly rational control. How can it be utilised to the full as food?

At present the industry is, of course, run almost entirely to procure oil. In post-War seasons, average whale oil production in the Antarctic has been about 375,000 tons, i.e. a 25% yield from 1½ million tons of whales. Since the War, whaling in other areas has increased and the total world production of oil is probably about 500,000 tons.

The oil, recovered from the blubber, bones and flesh, is mainly used for edible fat manufacture. Some goes for soap production. The price of whale oil is thus dependent on that of vegetable oils used for similar purposes. The term "whale oil" refers typically to the glyceridic oil of the baleen whales. The oil from the sperm and other toothed whales is waxy in character and is not used for food but for industrial purposes.

With certain exceptions, all parts of whales delivered to factory ships and shore stations must by regulation be processed by boiling or otherwise. Some whale meal and bone meal for animal feeding is made by drying the residues after oil separation. The Antarctic catch is controlled at 16,000 blue whale units or 1.3 million metric tons. This, according to Ash, is equivalent to 550,000 tons of whale meat. Only about 30,000 tons of meat are retained as such for human and animal consumption; possibly about 115,000 tons is made into whale meal. Nearly three-quarters of the available meat and, in consequence, a very large amount of valuable protein, is thrown to waste in the sea, as boiler sludge and stickwater. Losses of the same order appear to occur in dealing with the 235,000 tons of bone available, much valuable phosphorus being thrown away.

The limiting factor on the factory ships is space to accommodate drying plants, and only a few have any such plant at all. How, then, to increase greatly the production of whale meal, if only from flesh unsuitable for higher grade human and animal food products, is a standing challenge.

Whale livers are fully taken up for extraction of vitamin A, although there are still problems here in improving yield and lowering costs in the face of competition from synthetic production of the vitamin.

For long the Japanese, Norwegians, Icelanders and Faroese have eaten meat from locally caught whales, but the huge potential supplies of meat from the Antarctic had not been seriously considered for human feeding before 1947 by anyone save the Japanese. World food shortages have focussed attention strongly on the whale as a source of highly nutritious meat; but with the recent high price of oil, meat has been a minor by-product. Two *Special Reports* of the Food Investigation Organisation of the British D. S. I. R. have just appeared, and deal with the problems of bringing whale meat to the consumer in good condition. The reports describe the results of recent research on whaling expeditions and in Norway.

The 4 "fillets" of edible meat from the trunk and tail of an average blue whale weigh 7 to 10 tons. The meat has a flavour of its own, but it is sufficiently like beef to be taken for it in made-up dishes. It is usually coarser in texture and darker in colour than beef and less fatty. A recent F. A. O. review by Kondrup of various estimates gives what is thought to be a reasonable figure of between 200 and 300 thousand tons for the world potential of edible whale meat. There is clearly an objective here more immediately alluring than food production from plankton.

Edible whale meat contains from 0.5 to 13% of fat, which is rather similar in composition to fish oils generally and is easily oxidised. There is 15 to 19% of protein. Values for accessory food factors also appear to be similar to those for other meats.

The meat has, however, to be processed mainly on board ship and brought back from the far South; and 3 to 6 months' total storage may be necessary before marketing. The Japanese have for long salted the meat. This product would find little acceptance in the more developed countries, but might be welcome enough to more primitive, protein-deficient peoples, where they could afford to buy it.

Canning whale meat at sea has not been thoroughly explored. The economic difficulties imposed by the very short season are formidable. Some frozen meat has, however, been canned in Britain, Norway, and elsewhere with promising results.

The recent British investigations have concentrated on the production of frozen meat. Present methods of slaughtering and handling contravene most of the established principles of good slaughterhouse practice. The main drawback is the long interval between death and removal of meat from the carcass. Bacterial decomposition is very rapid in such well insulated, huge, hot-blooded animals, and renders a good deal of the meat unfit for human consumption. However, if the whaling ships were fitted with the necessary refrigeration and storage space, it is estimated that each factory ship could produce on the average about 3,000 to 4,000 tons of meat a year. Production from the whole Antarctic industry would then be between 57,000 and 76,000 tons a year. This development would take several seasons to complete even if prices for meat were much higher.

The British workers have shown that multiplication of bacteria in the flesh can be reduced significantly by reducing to the minimum the time between the resolution of *rigor mortis* and the freezing of the meat.

Confined space and conditions on a factory ship do not favour hygienic handling of the meat. The use, however, of a special raised meat handling deck and the washing of the meat with sterilised water have been found to reduce the bacterial load before freezing to a level comparable with that obtained in good slaughterhouses on land. The British Ministry of Food have sent meat inspectors with the expeditions bringing home meat for human consumption and laid down regulations for hygienic production.

In experiments on 2 British factory ships, composite blocks of 40 to 100 lbs. of meat have been frozen in metal moulds and stored at —10° C. after being "glazed" with ice. In laboratory tests the meat was preserved without noticeable deterioration at —10° C. for 10 months or longer by glazing with ice and wrapping it in moisture-vapour-proof material.

The present economic value of the meat is quite appreciable, selling in the U. K. at £90 per ton for dog food, a price now greater than that of the oil (£75). The higher costs of handling, storing, and transporting meat as compared with oil would,

however, have to be taken into consideration. There is also considerable consumer prejudice against whale products to be overcome. This would take time and money.

In recent years, only some 10,000 tons of meat have annually been frozen or canned for human consumption in Canada, Iceland, Norway, and the U. K. This is 6 or 7 times short of the target figures estimated for the Antarctic industry. So far, it must be admitted, it has not proved profitable to preserve whale meat at sea in a proper manner for human consumption, but there is no doubt that there is need for further technical and economic research and consumer education. The industry itself is well aware of possibilities as well as of difficulties and spends considerable sums on research on the fuller utilisation of the carcass.

## FISH AND SHELLFISH

*Production.* We now come to the major actual and potential food resource in the ocean, the fishes, including shellfish. Following present custom, let us also include fresh water fishes.

Statistics of world production are inadequate as yet, but F. A. O. is now systematically encouraging more accurate recording and is regularly collecting and publishing figures.

In 1945, Sandberg of the U. S. Fish and Wildlife Service, estimated the 1938-39 world production at just under 18 million metric tons. F. A. O. have given an estimate of the *actual* catch for 1949, based on their statistics. The figure was 25 million metric tons, and it was considered that even allowing for unrecorded subsistence fishing, it could not possibly exceed 30 million metric tons. At the F. A. O. Conference at the end of 1951, the fisheries experts present were satisfied that world fisheries resources were such that without risk to their future, the 1949 figure of 25 million tons could be doubled.

In a broadcast last year, Michael Graham, taking into account the great possibilities of expanding the culture of fresh water fish as well as those of exploiting marine resources more fully, hazarded a potential world total reaching up to 80 million metric tons. There, then, is the picture as the experts see it.

Generally speaking, fish can be produced at a lower labour cost than protein foods on land. U. S. A. returns, possibly not the highest, show a production of 33,000 lb. of corn-fed pork per worker per year, as against 66,000 of cod or 200,000 of sardines. With improved vessels, methods of fish detection and fishing, and mechanised fish handling, fish production per man-year may be yet further increased.

The 25 million ton estimated catch for 1949 is broken down by species as follows:

| | |
|---|---|
| (i) Miscellaneous species comprising a very great number of types | 25% |
| (ii) Herring and similar species, e.g. pilchards and anchovies | 21% |
| (iii) Fresh and brackish water species | 19% |
| (iv) Cod, hake and related species | 14% |
| (v) Tunas and mackerels | 6% |
| (vi) Salmon and similar species | 2% |
| (vii) Bony flat fishes | 2% |
| (viii) Elasmobranchs (skates, rays, sharks, etc.) | 1% |
| (ix) Crustaceans and molluscs | 8% |
| (x) Seaweeds, etc. | 2% |

Note the great predominance of the herring and cod and their allies, accounting for 35% of the world total. The contribution of 19% made by fresh water fishes is striking.

Sandberg's figures for 1938-39 showed that 98% of the world catch was taken in the Northern hemisphere, the North Atlantic contributing 46% and the North Pacific 47% and Indian Ocean 5%. The position today is not substantially different.

According to Thompson at the 1949 Conservation Conference, the poor yield of fish in the cold and temperate waters of the Southern hemisphere is due to the absence of embracing land areas, as well as to the scarcity of broad shelf and banks areas, so frequent in the Northern hemisphere, and to unsuitable bottom. In tropical and sub-tropical areas there is also a relative scarcity of suitable grounds, and, in addition, the waters are on the whole poor in nutrient salts. Total plankton and fish production is much lower than in colder waters and there is a great variety of species of fish, each, however, represented by comparatively few individuals.

With regard to the colder waters of the Southern ocean, which support such a large whale fishery, there is so far little evidence of significant quantities of either pelagic or bottom fish. In the sub-tropical and tropical regions, however, it is thought that pelagic fishes (tuna, mackerels, and herring-like species) offer good prospects of new or greater exploitation. Much study will be required of the migration and congregation of such species over a vast area and suitable methods of detection and of catching will have to be worked out. Existing Southern fisheries would require to be multiplied many-fold to add really substantially to the world supply; but there has recently been an encouraging, though overall slow, development of fisheries based on South America, South Africa, Asia and the Far East.

With respect to the Northern hemisphere, it seems to be fairly well agreed that there could still be very considerable expansion of the fisheries for herring and cod and their allies without 'diminishing returns.' There are also stocks of fish that are definitely under-fished or not being fished at all (e.g. Rosefish, Yellow tailed flounder, Long rough dab, Greenland halibut, etc., and many types of shore fishes and shell fish). Increased artificial culture of shell fish, both crustacea and molluscs, has very considerable possibilities.

Finally, there is a great undeveloped resource in the culture of fresh and brackish water fish in natural waters, and in special ponds, rice fields and the like, particularly if natural or artificial fertilisers are employed. It seems that the natural production of ponds in tropical countries is within the range of 445 to 1780 lb. per acre per year. On experimental stations, however, annual yields of more than 8,000 lb. per acre have been achieved. The highest yield per unit of surface is attained by stocking with vegetarian fish along with omnivorous species. From this source alone existing production might perhaps be quadrupled to yield about 20 million tons per annum. Inland Fisheries Extension work as well as research is being actively encouraged by F. A. O.

There is a vital need not only to exploit all latent fishery resources, but also to conserve existing resources and to obtain the maximum sustainable yield. Rational conservation can only be based on sound and sufficient data. Fisheries science is a long way yet from being adequate to interpret fluctuations in the stocks in terms of natural, uncontrollable and human, controllable causes, and to predict from year to year for any particular fishery what is likely to happen and so to guide planning for optimum exploitation at any particular period. Fisheries science has, however, progressed to the extent of recognising what, in a number of instances, have proved to be warning signs of approaching over-exploitation. With the increase in this sort of knowledge the prospects of ultimately wide-spread and co-operative conservation of the world's fish stocks will grow steadily brighter.

The man power deployed in fisheries research throughout the world is woefully insufficient. It is, however, growing very slowly, and co-ordination on an international basis will obviously result in increasing effectiveness. The type of co-ordination evolved by N. W. Europe about 1900 in the International Council for the Exploration of the Sea is now being followed in the establishment of various Regional Councils throughout the world. In this F. A. O. has played a prominent part.

## CONSUMPTION, PRESERVATION AND UTILISATION

A limit to our aquatic food resources appears to be coming into sight; but they will be exploited to that limit only if, apart from fishing, we can develop efficient and economic modes of utilising the catches directly or indirectly as food.

We need not stop to discuss the nutritive value of fish. This is everywhere acknowledged to be first class in all important respects. Consumption of fish flesh per head per year varies widely from place to place—from practically nil to a few lb. in North, East and South Africa, Eastern Europe, Central Asia and India, to as high as 55 to 100 lb. in Scandinavia, Iceland, Japan, Burma and the Philippines, where local production is intense. Protein deficient, as well as fish deficient,

populations are usually far from the major fisheries. Fisheries, moreover, are notoriously fluctuating or seasonal. Withal, fish is one of the most perishable of commodities.

These considerations indicate the basic problem—economic presentation of fish to the consumer in a palatable condition despite necessary lapse of time.

Heavy salting, drying or smoking, or combinations of these yield palatable products after months of storage. In earlier days this was the chief way of preserving, and of exporting fish. A third of the total catch of 25 million tons is still being treated thus, and accounting for a quarter of international trade.

Modern science has shown how improved hygiene, mechanised dressing, handling and processing, and equipment that affords control of temperature and humidity can improve both quality and storage life. These commodities, however, are going out of favour—in some cases have done so—in more developed countries, where the preference is for fresh fish or something like it. They may well, however—possibly in adapted forms which it will be the job of research to devise—continue for long to play as big a part as now in fish consumption. Marketing areas may gradually shift, however, as local deficiencies in purchasing power and trade difficulties disappear, and conservatism in dietary habits is overcome.

Just about half of the total world catch is marketed fresh, frozen, or canned, accounting for 35% of international trade. Of course, a substantial proportion of this gets 'lost' as inedible portion, although some is recovered as fish meal. Most of this fish is eaten by the more sophisticated populations, reflecting their preference for products resembling fresh fish. The modern sophisticated consumer also has a taste, varying from place to place, for fish lightly smoked to impart agreeable flavour rather than to afford preservation, which can, if desired, be obtained through freezing or canning. He also likes lightly treated variants of heavier traditional cures, such as salt-sugar-acid-spice pickled herrings and other delicatessen. Chilling and chemical preservatives are often used to prolong storage life.

Chilling with artificial ice, introduced late in the last century, enabled a very wide expansion of fishing area and of the distribution of 'wet' fish. Chilling, however, fails under the best conditions to preserve really fresh quality for more than about a week. Good hygiene and improved temperature-control in fishing vessels' holds, in transport vehicles and in processing houses can noticeably improve quality and storage life as against existing practice, but the limit is too soon reached for many purposes.

The distribution of fish fillets is common in all the more industrialized fishing countries, and is likely to increase. Collection of waste material for reduction purposes is thus greatly facilitated and carried weight is reduced.

Proper quick-freezing and sub-zero Fahrenheit storage is the best answer science has yet offered to the problem of preserving fish for months on end and of distributing it widely at a high level of quality. I think there will be very considerable development of this method yet for many years to come, despite the possible advent of sterilisation by radiations, still in the laboratory stage. There is, however, much to be done in raising trade practice to the level possible in the laboratory. The more this can be done, the sooner will disappear the prejudice against frozen fish, which is based to a large extent on the poor quality of products in the past.

To get good quality frozen fish it is essential to freeze the fish while still very fresh. Countries close to rich grounds are obviously at an advantage, e.g. Norway, Iceland and Newfoundland. On the other hand, a wide ranging fishery like the British "white" fishery must solve the problem of freezing at sea, and this you and we and some other nations are at present attempting to do in various ways to suit our special requirements. On balance, slow progress is being made, and one day we shall see the way through.

In the major fishing countries, the appropriate presentation of frozen fish is being steadily investigated—whether in small consumer packs or through the medium of cheaper-to-produce larger blocks for thawing and subsequent retail or processing as national and local habits dictate. Frozen cooked fish products too, may well meet with growing acceptance in the more highly industrialised countries.

Canning with its well recognised advantages vies with freezing in long-term preservation and surpasses it in ease of distribution. Technically, at least, it is the best method of distributing fish of high quality over wide areas, particularly in the warmer countries. The bulk of the fish canned are of the fatty variety, such as salmon, tunny and pilchard and herring. They are more suitable for the process in various ways than lean fish like cod and haddock. The field for experiment, however, in improving the variety and acceptability of fish packs, including the addition of suitable other ingredients and condiments, is large, and should be more fully explored.

Modern techniques of dehydration and the associated problems of storage are being studied in a number of places, and this may well result some day in fish products that can be reconstituted to really appetizing food. Success seems to lie along the road of approximating to the conditions that obtain in "vacuum-freeze-drying," at present an expensive process. Deterioration of dried fish in various ways (flavour, appearance, and texture) during storage is still little understood; and only continued fundamental research will show if there are feasible ways out of these difficulties.

About "by-products" comment will be confined to oil and meal production. In 1949 about 8% of the world catch, nearly 2 million tons, was reduced to oil and meal. A pre-War estimate suggests that as much as a third of the catch was reduced. Some of the meal comes from filleters' offal, surplus "white" fish and cannery waste, but most of it comes from direct reduction of surplus fatty fish like herrings, menhaden and pilchards. A large proportion of the oil is used for producing harder edible fats, while some is used in animal, e.g. poultry, feeding as a source of vitamin D, and the rest for various industrial purposes. The meal is largely used for animal feeding rations, although some is probably still used as fertilizer.

The problem of dealing with fluctuating surpluses of fish over existing means of disposal as direct human food is an ever recurring one, and in order to keep normal food channels steadily supplied and to avoid spasmodic restriction of fishing, there is no known method of "taking up the slack" so efficiently and expeditiously as reduction. In some places, however, and with regard to a particular species, reduction has assumed such over-whelming dimensions that the production of normal edible fish products appears as if it were merely incidental. As much as 80 to 90% of certain very large catches of fatty species are "reduced" in certain areas; and it seems that a good deal of the recent increase in the world's total catch has been absorbed in this way. Now it is much more efficient to turn fish protein directly into human protein than to send it first through a pig or other farm animal. Greater consideration therefore should always be given to stepping up direct consumption of fish as opportunity occurs.

In this connection, it may be, as some experienced observers have suggested, that underfed native populations would welcome or come to like fish meal as an addition to their customary vegetable stews and hashes. Limited trials with dehydrated cooked whole herrings rather support this. The economic and social difficulties that beset the wide distribution of even such a relatively cheap but unfamiliar product as fish meal must, however, be recognised. There is no doubt, too, that the diversion of much fish meal away from animal feeding would considerably hamper food animal and egg producers as well as diminish the quality and rate of production to which we are accustomed.

In reducing herring or similar fish, some 20% loss of meal output can be occasioned by rejecting "stick water" after separation of oil from the press liquor. This "stick water" contains some 6 to 10% of solids, comprising protein, amino acid and other nitrogenous extractives as well as accessory food factors, notably the "animal protein factor." For nearly a decade now, particularly in America, "stick water" has been evaporated to "condensed fish solubles" and sold profitably as an animal feeding supplement. There seems to be no doubt that this feeding material is specially valuable where animals are being fed *mainly* on certain vegetable stuffs, e.g. corn or soy-bean. In any case, waste of food material should be minimised, if possible. However, the major part of the world production of "stick water" is still being run to waste. How to recover and use this waste to the best advantage is now being studied in a number of countries.

## CONCLUSION

It is true, as Harden Taylor has pointed out, that the picture from the commercial angle has a rather dismal aspect. To speak only of fish, the most abundant species can be produced at present more cheaply in man years and in financial reward to the primary producer than any other important source of high grade protein. If we had stepped up world fish production to, say, 50 million tons p.a., this would be equivalent to only about 3½ g. protein per head per day, if it were all used directly. It doesn't seem very much, but distributed in the right, needy places would mean a lot more. But even with relatively cheap and efficient production it is at present extremely doubtful if the people who need the protein most could fully pay for it.

Nevertheless, one need not take the pessimistic view that, try as we will, it will never pay to tap the resources of the sea on a fuller scale than we do now, and to use them mainly for feeding a much larger proportion of the earth's inhabitants.

As time goes on, and circumstances change, as they always do, and despite the many difficulties, technical and otherwise, that now confront us, scientists, technologists, business men and Governments in combination will develop an increasingly determined will to find and then to use ever more effective ways of securing and utilising the harvest of the sea in relation to the use of other food resources. It may be that as populations continue to press increasingly on food supplies, we shall come to feel that it will be "profitable" in the broadest sense to seek these ways more diligently.

* * *

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## LITERATURE CITED


1. Ash, C. E. The body weights of whales. *Norwegian Whaling Gazette*, July 8, 1952. (*Norsk Hvalfangst Tidende*, Sandefjord, Norway), **41** (7), 364 (1952).
2. Clarke, G. L., and Bishop, D. W. The nutritional value of marine zooplankton with a consideration of its use as an emergency food. *Ecology*, **29** (1), 54 (1948).
3. Cutting, C. L. Economic aspects of the utilization of fish. Biochemical Society *Symposia*, (6) (1951).
4. *F. A. O. Fisheries Bulletin*, **4** (6), (1951). Account of Sixth Session of F. A. O. Conference, Rome, 1951.
5. G. M. G. Estimates of world catches by species groups and by utilization. *F. A. O. Fisheries Bulletin*, **4** (6), (1951).
6. Graham, M. How much is left in the sea larder? *World Fishing*, **1** (9), 350 (1952).
7. Hardy, A. C. Plankton as a source of food. *Nature*, **147** (3736), 695 (1941).
8. Kondrup, M. Whalemeat: a potential protein food resource. *F. A. O. Fisheries Bulletin*, **5** (5), 184 (1952).
9. Lucas, C. E. Harvesting the waters. In: *Four Thousand Million Mouths*. (Ed. Le Gros Clark, F. and Pirie, N. W.), Oxford University Press (1951).
10. *Proceedings* of the United Nations Scientific Conference on the Conservation and Utilization of Resources. *Vol. VII*, Wildlife and Fish Resources. U. N. Department of Economic Affairs, New York, 1951.
11. Reay, G. A., and Cutting, C. L. The preservation and use of fish. In: *Four Thousand Million Mouths*. (Ed. Le Gros Clark, F. and Pirie, N. W.), Oxford University Press (1951).
12. *Report of the Technical Committee on Fisheries*. Submitted to the United Nations Interim Commission on Food and Agriculture, April 13, 1945. Washington, D. C.
13. Robinson, R. H. M., and Others. Whalemeat: bacteriology and hygiene. Department of Scientific and Industrial Research, Food Investigation *Special Report No. 59*, 1953. H. M. Stationery Office, London.
14. Ruud, J. T. Modern whaling and its prospects. *F. A. O. Fisheries Bulletin*, **5** (5), 165 (1952).
15. Sandberg, A. M. The fisheries of the world. U. S. Fish and Wildlife Service, *Fishery Leaflet No. 109* (1945).
16. Schuster, W. H. The role of extension services in inland fisheries. *F. A. O. Fisheries Bulletin*, **5** (2), 41 (1952).
17. Sharp, J. G., and Marsh, B. B. Whalemeat: production and preservation. Department of Scientific and Industrial Research, Food Investigation *Special Report No. 58*, 1953. H. M. Stationery Office, London.
18. Sverdrup, H. V. Some aspects of the primary productivity of the sea. *F. A. O. Fisheries Bulletin*, **5** (6), 215 (1952).

# A Rapid Method for the Presumptive Identification of Bacteria Which Have Been Associated With Off-Flavors and Odors in Concentrated Orange Juice

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**A rapid procedure for identifying bacteria isolated from off-flavored orange juice concentrate is presented. The method is based upon cell morphology, gram and catalase reactions, relation to oxygen, and growth in sucrose-gelatin. Acetic acid bacteria were determined qualitatively by means of ethanol oxidation in media at pH 4.1.**

The primary concern of the citrus concentrate industry is the production of a high quality product having wide consumer acceptance. Consequently, the occasional occurrence of a batch of concentrate of inferior quality is of vital concern.

Because the acidity and low pH value of orange juice prevent the growth of most types of bacteria, only a few species have been isolated from citrus products or citrus plant equipment. Faville and Hill *(1)* isolated bacteria of the genera *Lactobacillus, Leuconostoc, Aerobacter, Xanthomonas,* and *Achromobacter* from rotten oranges or spoiled juice. They report certain strains, representing all five genera, to be capable of growth in juice of pH 4.0 or below.

In recent years, the appearance of abnormal flavors in orange concentrate has been observed—flavors described as similar to those characterizing buttermilk. Hays *(2)* isolated the causative organisms from evaporator effluents which had developed flavors of this nature and identified them as *Lactobacillus plantarum* and *Lactobacillus brevis.* Hays and Reister *(3)* reported *Leuconostoc mesenteroides* and *Leuconostoc dextranicum* in addition to lactobacilli were possible spoilage bacteria. Murdock, Troy and Folinazzo *(7)* studied the development of off-flavors in 20° Brix orange concentrate inoculated with strains of *Leuconostoc* and *Lactobacillus.* In our laboratory, bacteria belonging to these two genera were isolated from off-flavored concentrate and substantiated the findings of others that lactic acid bacteria are associated with off-flavor development.

In 1951, a number of strains of bacteria isolated from spoiled orange concentrate were identified as conforming most closely to the genus *Acetobacter.* These organisms were strong acidifiers and produced a marked souring when grown in juice or 20° Brix concentrate.

Because the identification of significant bacteria is of value in organizing knowledge pertaining to the control of orange concentrate spoilage, the purpose of this paper is twofold: to set forth the distinguishing characteristics of certain bacteria known to cause spoilage—namely, those belonging to the genera *Lactobacillus, Leuconostoc,* and *Acetobacter;* and to present a procedure whereby they may be rapidly segregated.

## EXPERIMENTAL PROCEDURE

**Source of cultures.** The following test strains were used in the study: 819, 824, 856 *(Lactobacillus sp.)*, 844 *(L. brevis)*, 845 *(L. plantarum)*; 853, 854, 855, 898 *(Leuconostoc sp.)*, 825, 894 *(L. mesenteroides)*; 811, 815, 817 *(Acetobacter sp.)*. All organisms were originally isolated from either off-flavored 42° Brix orange concentrate or off-flavored juice at various stages in the preparation of concentrate. In addition, type cultures of *Acetobacter* species were used as controls. These were 7839 *(A. rancens)*, and AO 9322 *(A. suboxydans)* obtained from the American Type Culture Collection, and B681 *(A. oxydans)*, and MA112 *(A. melanogenum)*.[b]

**Methods.** Cultural and biochemical reactions of isolates were determined according to the *Manual of Methods for Pure Culture Study of Bacteria (5).*

Active cultures of all strains were carried on orange serum agar slants *(6)*, transfers being made twice a week. Stock cultures of the lactic acid bacteria were maintained in liver broth *(12)* and after growth had occurred at 30° C. (86° F.) were stored at 5° C. (41° F.). Subcultures were made at approximately 6-month intervals. *Acetobacter* species were kept on slants of a medium containing 1% glucose, 0.5% Difco Yeast Extract, 1.0% Difco tryptone, 0.1% $K_2HPO_4$, 1 to 2% precipitated $CaCO_3$, and 2% agar. These cultures were also stored at 5° C. (41° F.) after being grown at 30° C. (86° F.), and were transferred frequently.

Sucrose-gelatin medium (8, 4) was used to demonstrate dextran production by the *Leuconostoc* strains, but the behavior of *Acetobacter* and *Lactobacillus* organisms was also determined in this medium. Two formulations were used, each subsequently found to yield comparable results: (a), 10% sucrose, 0.5% glucose, 12% gelatin, and 2% trypticase (B. B. L.); (b), 10% sucrose, 0.5% glucose, 12% gelatin, 0.5% Difco Yeast extract, 1.0% Difco tryptone, and 0.1% $K_2HPO_4$. The unadjusted pH of both media was 6.8. In preparation, the melted media were dispensed in tubes to a depth of 8-10 cm., sterilized, and cooled to below 25° C. (77° F.) to cause solidification. Tubes were inoculated with a needle containing a small amount of cellular growth by making a single straight deep stab. Incubation was at 20° and 25° C. (68° and 77° F.). For most convenient inoculation, the optimum temperature of the sucrose gelatin medium was found to be about 20° C. (68° F.).

Qualitative determination of ethanol utilization by *Acetobacter* species was conducted on ethanol-$CaCO_3$ agar and also in ethanol broth adjusted to pH 4.1 with 1.0 *N* HCl. The basal medium consisted of 0.5% Difco Yeast extract, 1.0% Difco Tryptone, 0.1% $K_2HPO_4$, and for the solid medium, 0.5% precipitated $CaCO_3$ and 2% agar. After sterilization and cooling, absolute ethanol was aseptically added to give a concentration of 2%. Streak plates of the agar were made using heavy suspensions of the organisms. Twenty-five ml. portions of the broth in 8 oz. screw-cap bottles were inoculated and the bottles laid flat to provide for maximum aerobic conditions. In all cases, controls containing no ethanol were also inoculated. Incubation was at 30° C. (86° F.).

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[b] Obtained from the University of California.

## RESULTS

**Cultural and biochemical reactions.** Diagnostic characteristics of the 3 genera of test organisms are summarized in Table 1.

Sucrose-gelatin (Figure 1) was found to be a useful differtial growth medium. Optimum time-temperature relations for incubation were either 3 days at 25° C. (77° F.) or 5 to 6 days at 20° C. (68° F.). The highest temperature at which the medium remained solid, 25° C. (77° F.), gave more rapid results than 20° C. (68° F.); however, continued incubation beyond 3 days resulted in the gradual development of an atypical diffuse growth with lactobacilli strains 819 and 845 which approached that produced by *Leuconostoc* organisms. At 20° C. (68° F.) 5 to 6 days were required for positive growth of *Lactobacillus* strain 844.

The oxidation of ethanol to acetic acid, a distinguishing characteristic of bacteria of the *Acetobacter* group, was demonstrated by the use of ethanol $CaCO_3$ agar on which cleared areas developed after 2 to 3 days as a result of growth and production of acid (Figure 2). Inoculated control plates supported growth but the medium remained opaque. All test strains utilized ethanol in the broth at pH 4.1 as evidenced by a marked reduction in final pH value which ranged from 3.3 to 3.8 for the citrus isolates after 4 days incubation. The pH of the control broth either remained constant or increased.

All test strains grew in both 20° Brix orange concentrate and single strength juice and produced marked off-flavors and odors. The acidity produced by growth of *Acetobacter* organisms caused the pH value to drop significantly. After 4 days at 30° C. (86° F.) the final pH of inoculated juice having an initial value of 3.8 ranged from 2.5 to 2.9. Similar results were observed in 20° Brix concentrate.

Orange serum agar, the most commonly used plating medium in the citrus industry, produces typical colony characteristics for bacteria of the genera *Lactobacillus* and *Leuconostoc*, and thus enables these organisms to be differentiated when they occur as a mixed culture. *Acetobacter* colonies were found to be easily confused with those of the 2 former genera when grown on orange serum agar. Sub-surface colonies were small owing to reduced oxygen tension and resembled a *Lactobacillus* colony. Surface colonies of a good proportion of the *Acetobacter* strains were mucoid, translucent, and resembled many *Leuconostoc* colonies.

The *Lactobacillus* strains 819 and 856 were homofermentative and 824 heterofermentative as determined by means of Eldredge

**TABLE 1**
**Generic differentiation of Lactobacillus, Leuconostoc and Acetobacter**

| Characteristic | Genus | | |
|---|---|---|---|
| | *Lactobacillus* | *Leuconostoc* | *Acetobacter* |
| Cell morphology | Short to medium rods | Cocci | Ellipsoidal to short rods |
| Gram stain | Positive | Positive | Negative |
| Catalase reaction | Negative | Negative | Positive |
| Growth on orange serum agar slant | | | |
| a. Surface | Scanty | Gummy | Good |
| b. Sub-surface | Filiform | Filiform | No growth |
| Orange serum agar colonies | Small, whitish, circular | Translucent, gummy, circular | Slightly raised, often mucoid, circular |
| Oxygen requirement | Facultative | Facultative | Strict Aerobe |
| Growth in sucrose-gelatin stab | Filiform | White, mucoid cotton like | Restricted to surface |
| Gelatin hydrolysis | Negative | Negative | None to very slight |
| Pigment formation | Negative | Negative | Negative |
| Oxidation of ethanol | Negative | Negative | Positive |
| Flavor produced in pH 3.7 20° Brix orange concentrate | Sour, buttermilk, sauerkraut-like flavors and odors. Development of sourness very pronounced with *Acetobacter*. | | |

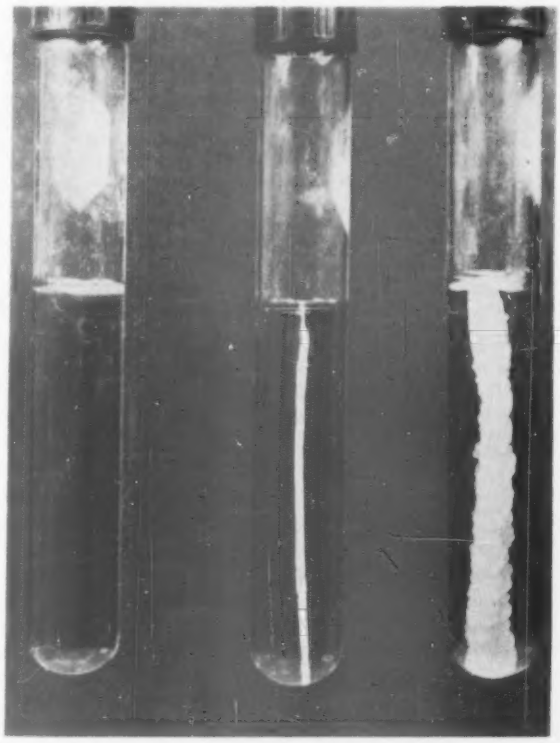

**Figure 1. Sucrose-gelatin stab cultures illustrating from left to right, typical growth characteristics of bacteria of the genera Acetobacter, Lactobacillus and Leuconostoc.**

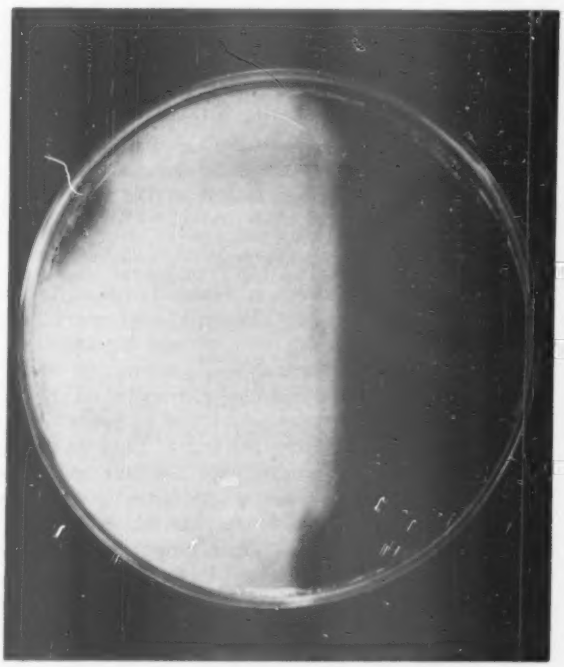

**Figure 2. Ethanol-$CaCO_3$ plate showing cleared area resulting from growth and acid production by bacteria of the genus Acetobacter.**

tubes *(5)*. The optimum growth temperature for all 3 isolates was approximately 37° C. (98.6° F.) but none grew at 44° C. (111.2° F.). Strain 819 produced acid from sucrose but not from lactose, arabinose or raffinose. Strain 856 produced acid from all 4 sugars, and strain 824 utilized all but raffinose. On this basis, culture 819 might be identified as one of 3 species, *L. leichmanni, L. casei,* or *L. plantarum*. Strain 856 most nearly resembled *L. plantarum* as described by Pederson *(9)*. Strain 824 conformed closely to *L. brevis* or *L. buchneri* as described by Pederson *(10)*.

All 4 unidentified *Leuconostoc* species were heterofermentative. Rapid growth occurred from 20° to 37° C. (68° to 98.6° F.) with an optimum of approximately 30° C. (86° F.). None grew at 44° C. (111.2° F.). The strains fermented sucrose but not xylose or arabinose and were therefore identified as the species *L. dextranicum (10)*.

A detailed characterization of the 3 unidentified *Acetobacter* strains was not conducted. However, they did not utilize ammonium salts as a sole source of nitrogen in Henneberg's medium *(12)*, did not form pigments from glucose, produced thin, hardly noticeable films to thin, dry wrinkled films on broth and had optimum growth temperatures of approximately 30° C.

### A Rapid Presumptive Identification Procedure

The following procedure is suggested for the rapid segregation of citrus isolates belonging to the genera *Lactobacillus, Leuconostoc,* and *Acetobacter:* Individual colonies are fished from orange serum agar plates and both streaked and stabbed on orange serum agar slants. All subsequent determinations or inoculations are made from the first slants after approximately 24 hours incubation at 30° C. (86° F.).

Gram reaction, cell morphology, and ability to grow in the depths of orange serum agar stabs are determined. Presence of the enzyme catalase is determined by applying cell material with a bacteriological loop to a drop of freshly prepared 3% hydrogen peroxide on a glass slide and observing for formation of gas bubbles. Sucrose-gelatin tubes are inoculated. If strictly aerobic, catalase positive organisms, suspected of being acetic acid bacteria are encountered, the ethanol media also are inoculated. Ability of isolates to grow in orange juice and 20° Brix concentrate should be determined to establish their significance as possible spoilage organisms. The orange juice or concentrate should have for this purpose a chemical composition similar to that from which isolations were originally made.

## DISCUSSION

Taxonomically, the acetic acid bacteria belong to the family *Pseudomonadaceae*. Vaughn *(12)* compared and contrasted the genera *Acetobacter* and *Pseudomonas* and indicated that whereas the 2 genera are closely related, *Acetobacter* species are tolerant of acid surroundings. They are commonly found in spoiled beer, spoiled wine, and in fermenting fruits. Bacteria of the genus *Pseudomonas*, however, are soil and water organisms and prefer a more neutral environment. At one time, the general belief was that the oxidation of ethanol to acetic acid was the distinguishing characteristic of acetic acid bacteria. Stanier *(11)*, however, reported that certain pseudomonads also possessed this ability, but only at pH levels that approach neutrality. When the pH of the medium fell below 5.0, the organisms studied by Stanier rapidly died out. For this reason, it is felt that strict aerobic, catalase-positive, gram-negative bacteria isolated from citrus juice or concentrate which oxidize ethanol as determined on ethanol-$CaCO_3$ agar, and which will grow and produce spoilage when subcultured into juice or 20° Brix concentrate may be presumed to be acetic acid bacteria. Growth in ethanol broth at pH 4.1 which results in decreases in the initial pH value provides additional evidence—Vaughn *(13)*.

The identification pattern outlined is based upon existing knowledge of distinguishing generic characteristics. It is stressed that the characterization procedure is presumptive, and applies only to certain isolates or other bacteria of the same species known to be significant spoilage organisms. Confirmed identification of isolates would necessitate additional cultural and biochemical studies including quantitative determinations of metabolic end-products. In most citrus microbiological control work, however, the value of a complete characterization of isolates does not warrant the additional time and effort required.

## SUMMARY

A rapid and comparatively simple segregation technique for the 3 genera *Lactobacillus, Leuconostoc* and *Acetobacter* isolated from off-flavored orange concentrate is presented. This procedure is based upon cell morphology, gram and catalase reactions, relation to oxygen, growth characteristics in sucrose-gelatin and, in the case of acetic acid bacteria, the qualitative determination of ethanol oxidation in media at pH 4.1.

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## LITERATURE CITED

1. Faville, L. W., and Hill, E. C. Recent investigations pertaining to acid-tolerant bacteria in citrus juices. Second Annual Citrus Processors Meeting, Citrus Experiment Station, Lake Alfred, Fla., Oct. 9, 1951.
2. Hays, G. L. The isolation, cultivation and identification of organisms which have caused spoilage in frozen concentrated orange juice. *Proc. Florida State Hort. Soc.*, 64th Annual Meeting (1951).
3. Hays, G. L., and Riester, D. W. The control of "off-odor" spoilage in frozen concentrated orange juice. *Food Technol.*, **6**, 386 (1952).
4. Hucker, G. J., and Pederson, C. S. Studies on the Coccacceae. XVI. The genus *Leuconostoc*. N. Y. (Geneva) Agr. Expt. Sta., *Tech. Bull. 167* (1930).
5. Manual of methods for pure culture study of bacteria. Leaflet V, 12th ed., 1951, and Leaflet VI, 9th ed., 1942, *Bio Tech. Publications*, Geneva, N. Y.
6. Murdock, D. I., Folinazzo, J. F., and Troy, V. S. Evaluation of plating media for citrus concentrates. *Food Technol.*, **6**, 181 (1952).
7. Murdock, D. I., Troy, V. S., Folinazzo, J. F. Development of off-flavor in 20° Brix orange concentrate inoculated with certain strains of lactobacilli and Leuconostoc. *Food Technol.*, **6**, 127 (1952).
8. Pederson, C. S. (Personal communication, 1952).
9. Pederson, C. S. A study of the species *Lactobacillus plantarum* (Orla-Jensen) Bergey *et al. J. Bact.*, **31**, 217 (1936).
10. Pederson, C. S. The gas producing species of the genus *Lactobacillus, J. Bact.*, **35**, 95 (1938).
11. Stanier, R. Y. Acetic acid production from ethanol by fluorescent pseudomonads. *J. Bact.*, **54**, 191 (1947).
12. Vaughn, R. H. The acetic acid bacteria. *Wallerstein Labs. Commun.*, **5**, 5 (1942).
13. Vaughn, R. H. (Personal communication, 1952).

# Application of Formamide as an Extraction Solvent With Karl Fischer Reagent for the Determination of Moisture in Some Food Products

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**Formamide was investigated as an extraction solvent for use with Karl Fischer reagent for the determination of moisture in beans, cake mix, dried whole eggs, egg noodles, rolled oats, potato starch, rice, wheat, and garlic, onion, orange, and tomato powders. Formamide was found to be more versatile than methanol, the commonly used extraction solvent. The results obtained are reported and compared with those determined by vacuum-oven methods.**

The commonly used vacuum-oven drying techniques for the determination of moisture in food products leave much to be desired as they are usually time consuming and empirical. Methods for the determination of moisture in foodstuffs using the Karl Fischer reagent are more rapid and possibly less empirical than oven drying procedures and are assuming increasing importance in manufacturing plants and inspection laboratories where a rapid moisture method, which is always desirable, is often mandatory.

The advantage of using Karl Fischer reagent for quantitative determination of moisture in dried food products and food mixtures of low residual water content have been discussed in earlier papers from this Laboratory *(3, 5, 6)*, as well as by other investigators *(2, 8, 9)*.

Methods which have been reported for the determination of moisture in dried food products by the Karl Fischer titration require heating or refluxing of a methanolic suspension of the sample for varying lengths of time before titration with the reagent. The difficulty in obtaining a rapid and quantitative moisture value on dry food materials when methanol was used as the extraction solvent led to the search for a more favorable and selective solvent. The utility of formamide as a solvent for both water and plant carbohydrates such as pectin and starch *(1)* suggested its use for materials not readily extracted by methanol and the application of formamide as an extraction solvent for dehydrated potatoes, sweet potatoes, carrots, and peas has been reported *(6)*. Schroeder and Nair *(9)* found that refluxing for several minutes or standing at room temperature for several hours in methanol was necessary to obtain satisfactory Fischer moisture values for noodles and onion powder. Johnson *(3)* refluxed tomato and orange powder for 30 minutes at 60° C. to obtain Fischer moisture values in agreement wth oven methods. He also reported that 30 minutes' soaking at room temperature for dried eggs was required to obtain satisfactory moisture values. The authors have essentially confirmed the conditions of extraction described by Schroeder and Nair *(9)* and Johnson *(3)*. It was also found that the time required to extract the water from beans, rice, wheat, and oatmeal in methanol was greater than 3 hours. Because of the need for a more rapid extraction solvent, methanol was not included in this investigation. This paper presents a study of the determination of moisture in beans, cake mix, egg powder, egg noodles, rolled oats, potato starch, rice, and wheat and in garlic, onion, orange, and tomato powders by use of formamide as the extraction solvent. Most of the materials studied required no preliminary heating to extract the water from the sample; however, a simple procedure was devised when heating was required. Results of the formamide extraction-Fischer titration were compared with those obtained by vacuum oven methods. Formamide was found to be a rapid and versatile extraction solvent for the materials studied.

## EXPERIMENTAL

The apparatus and the reagents used were similar to those previously described *(6)*. The procedure was as follows: The water equivalent of the Fischer reagent and the blank titer of 20 ml. of formamide were determined daily or each time a series of determinations was made. A quantity of the sample, calculated to give a suitable titer, was weighed into a dry, glass-stoppered 250-ml. Erlenmeyer flask which contained a magnetic stirring "flea." Twenty ml. of formamide was added with slight agitation to disperse the sample and prevent clumping. The samples which were found to require no heating were stirred on a magnetic stirrer for 5, 10, and 15 minutes, then titrated directly with Fischer reagent. The samples which required heating were placed on an aluminum plate, approximately ½ inch thick, in an air oven maintained at 70° or 80° C. for the various time intervals indicated. They were then removed, cooled and titrated. The percent water was calculated as follows:

$$\% = \frac{100\ (\text{sample titer} - \text{blank titer})\ (\text{water equivalent})}{(\text{sample weight in mg.})}$$

Water equivalent = mg. of water titrated by one ml. of Fischer reagent.

## RESULTS AND DISCUSSION

It was found in our previous work *(6)* that the conditions for solubilizing the material to insure availability of the water for titration varied for different materials in the same general category. For instance, dried vegetables differ in their chemical composition and physical properties and require varying conditions for the formamide extraction. Consideration must be given to the particle size as well as the time and temperature of the formamide treatment. Rolled oats, rice, beans, and wheat required grinding and an effort was made to use the smallest particle size practical. These samples were

[a] Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

ground to pass a 40-mesh screen *(4)*, with the exception of rolled oats which were ground with difficulty to pass a 20-mesh screen.

The method previously used for heating the sample-formamide-suspension was replaced by heating in an oven provided with a good heat-conducting metal plate. A greater number of samples can be heated more uniformly in an oven and, although the time for a single analysis is longer, the better precision of results and the increase in the possible number of determinations justify its use.

Table 1 shows the conditions investigated for the treatment of the sample-formamide suspension before titration with Karl Fischer reagent, and the results of this investigation compared with vacuum oven drying. Samples of potato starch, egg noodles, cake mix, and dried whole eggs, when stirred and titrated without heating, gave satisfactory moisture values. Rolled oats, rice, beans, and wheat required heating and the table shows the variation in heating time and temperature required for complete extraction of the water from the sample. The extraction of the water by the formamide was considered to be complete when further soaking or heating failed to remove additional moisture. Moisture values were not increased by heating for 50 minutes at 70° and 80° C. At a temperature of 90° C. for 5 to 30 minutes the results were substantially the same as those obtained at the lower temperatures, but the precision was poor, suggesting that side reactions may be occurring or that water may be volatilized and, therefore, not titrated.

**TABLE 1**

**Oven and Fischer values on the materials studied**

| Material | Percent moisture | | | |
|---|---|---|---|---|
| | Vacuum oven 100° C. 5 hr. | Fischer titration | | |
| | | No heat | 70° C. | 80° C. |
| Beans (40-mesh) | 10.46<br>10.44 | | 5 min. 9.66<br>10 min. 10.10<br>30 min. 10.12 | 5 min. 9.86<br>10 min. 10.27<br>30 min. 10.42 |
| Cake mix | 3.76<br>3.81 | 5 min. 3.92<br>10 min. 4.06<br>15 min. 3.93 | 5 min. 4.03<br>10 min. 3.92<br>30 min. 4.12 | |
| Dried whole eggs | 5.70<br>5.72 | 5 min. 5.42<br>10 min. 5.51<br>15 min. 5.56 | 5 min. 5.39<br>10 min. 5.46<br>30 min. 5.50 | |
| Egg noodles (40-mesh) | 12.65<br>12.64 | 5 min. 12.03<br>10 min. 12.03<br>15 min. 12.03 | 5 min. 12.04<br>10 min. 12.22<br>30 min. 12.19 | |
| Oatmeal (20-mesh) | 9.51<br>9.44 | | 5 min. 9.14<br>10 min. 9.25<br>30 min. 9.18 | 5 min. 9.46<br>10 min. 9.49<br>30 min. 9.52 |
| Oatmeal (whole) | 9.94<br>9.97 | | 5 min. 9.34<br>10 min. 9.39<br>30 min. 9.31 | 5 min. 9.73<br>10 min. 9.62<br>30 min. 9.79 |
| Potato starch | 11.49<br>11.46 | 5 min. 11.48<br>10 min. 11.44<br>15 min. 11.45 | 5 min. 11.45<br>10 min. 11.38<br>30 min. ..... | |
| Rice (40-mesh) | 11.71<br>11.68 | | 5 min. 11.77<br>10 min. 11.71<br>30 min. 11.83 | 5 min. 11.84<br>10 min. 11.72<br>30 min. 11.68 |
| Wheat (40-mesh) | 10.94<br>10.97 | | 5 min. 10.74<br>10 min. 10.69<br>30 min. 10.66 | 5 min. 10.8<br>10 min. 10.79<br>30 min. 10.77 |

The comparative vacuum oven values do not always agree exactly with those found by the Fischer titration. The accuracy of the Fischer method is difficult to demonstrate because it is not known with certainty that the vacuum oven method used gives correct results for the moisture content. For the cereals, starch, cake mix, and egg products, the method recommended by the Association of Official Agricultural Chemists *(7)* was used. Instances where the Fischer moisture values are lower than oven values suggest that the oven conditions chosen were too rigorous for such materials.

Because no reliable reference methods were available for most of the food powder samples studied, an investigation was made of the results of 6, 16, 24, and 48-hour heating times at 60° and 70° C. under vacuum. Table 2 shows the results obtained. Heating in formamide was not required for any of the powder samples and this solvent was particularly superior to methanol for moisture determinations in samples containing an appreciable quantity of filler, such as corn syrup solids. Methanol gave lower values than formamide due to the insolubility of the filler in a methanolic suspension.

**TABLE 2**

**Powder samples**

| Material[b] | Percent moisture | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Vacuum oven | | | | | | | | Fischer method |
| | Hours at 60° C. | | | | Hours at 70° C. | | | | |
| | 6 | 16 | 24 | 48 | 6 | 16 | 24 | 48 | |
| Garlic, regular grind | 5.54<br>5.55 | 5.86<br>5.86 | 5.89<br>5.90 | 5.89<br>5.95 | 5.75<br>5.78 | 5.91<br>5.92 | 5.97<br>5.94 | 6.03<br>6.05 | 6.02<br>6.06 |
| Garlic, coarse grind | 5.66<br>5.67 | 6.19<br>6.19 | 6.23<br>6.25 | 6.35<br>6.37 | 5.89<br>5.99 | 6.33<br>6.32 | 6.33<br>6.28 | 6.46<br>6.44 | 6.38<br>6.32 |
| Onion, regular grind | 3.76<br>3.78 | 3.97<br>3.97 | 3.98<br>4.01 | 4.10<br>4.12 | 3.92<br>3.95 | 4.27<br>4.29 | 4.31<br>4.37 | 4.31<br>4.30 | 4.11<br>4.15 |
| Onion, coarse grind | 2.69<br>2.72 | 3.01<br>3.01 | 3.14<br>3.09 | 3.25<br>3.22 | 2.94<br>2.96 | 3.35<br>3.39 | 3.42<br>3.42 | 3.42<br>3.43 | 3.36<br>3.38 |
| Orange, containing corn syrup solids (40%) | 1.65<br>1.44 | 2.64<br>2.59 | 2.56<br>2.62 | 2.85<br>2.84 | 2.84<br>2.80 | 3.48<br>3.41 | .....<br>..... | 3.39<br>3.32 | 2.82<br>2.79 |
| Orange | 2.29<br>2.17 | 2.91<br>2.96 | 3.07<br>3.18 | 3.30<br>3.31 | 3.40<br>3.36 | 4.01<br>3.99 | .....<br>..... | 3.95<br>3.96 | 3.21<br>3.18 |
| Tomato | 1.54<br>1.60 | 2.12<br>2.15 | 2.37<br>2.39 | 2.74<br>2.73 | 2.11<br>2.03 | 2.61<br>2.61 | 2.77<br>2.77 | 3.34<br>3.32 | 2.49<br>2.55 |

[b] The garlic and onion powders were commercial products.

## SUMMARY

In determining moisture in dry food materials, the Karl Fischer method and the use of formamide as an extraction solvent offer certain advantages over the more commonly used procedures. This method has the advantages of speed, simple manipulations, and good precision.

## LITERATURE CITED

1. Carson, J. F., Jr., and Maclay, W. D. The acylation of polyuronides with formamide as a dispersing agent. *J. Am. Chem. Soc.*, **68**, 1015 (1946).
2. Fosnot, R. H., and Haman, R. W. A preliminary investigation of the application of the Karl Fischer reagent to the determination of moisture in cereals and cereal products. *Cereal Chem.*, **22**, 41 (1945).

3. Johnson, C. M. Determination of water in dry food materials. Application of the Fischer volumetric method. *Ind. Eng. Chem., Anal. Ed.*, **17**, 312 (1945).
4. Makower, B., Chastain, S. M., and Nielsen, E. Moisture determination in dehydrated vegetables. Vacuum oven method. *Ind. Eng. Chem.*, **38**, 725 (1946).
5. McComb, E. A. Determination of moisture in some protein materials. *Anal. Chem.*, **20**, 1219 (1948).
6. McComb, E. A., and McCready, R. M. Rapid determination of moisture in dehydrated vegetables with Karl Fischer reagent by use of formamide as an extraction solvent. *J. Assoc. Offic. Agr. Chemists*, **35**, 437 (1952).
7. *Methods of Analysis*, A. O. A. C., 13.3, 7th Ed. (1950).
8. Mitchell, J., Jr., and Smith, D. M. *Aquametry*. 1948, Interscience Publishers, Inc., New York.
9. Schroeder, C. W., and Nair, J. H. Determination of water in dry food materials. *Anal. Chem.*, **20**, 452 (1948).

# Damage to Crops from Parasitic Fungi and Insects*

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The colonists who came to the New World found many serious plant diseases in the meadows and woodlands. Fireblight of pear and apple apparently was indigenous to the Hudson River Valley in New York. It occurred on many rosaceous plants but was not recognized widely until susceptible varieties of pears were introduced from France.

The fine wine grapes of Europe were considered to be unadapted to the New England States because they died out within a year or two. We now know that these varieties were so susceptible to downy mildew that they were killed by this fungus. After the colonists had developed their own native varieties of grapes, the European wine growers imported them for breeding purposes. In so doing they imported the downy mildew fungus into the completely susceptible vineyards of southern France in 1878 or the year before. The disease appeared in Italy the following year and then spread northward with explosive violence so it was distributed throughout Europe by 1881. The grape industry would have been doomed had not Bordeaux mixture been discovered. Thus, the first of the protective fungicides was introduced under these dramatic conditions although the therapeutic value of sulfur had been known for many years previously.

These examples illustrate the most extreme emergencies under which a plant pest can threaten a crop. Whenever a susceptible new crop is introduced into an established population of pests or a new fungus or insect is introduced into a crop area there are devastating losses. American agriculture has experienced the onslaught of several pests that were inadvertently introduced. The European corn borer is still extending its area of infestation westward so it is a constant threat to corn culture. The Japanese beetle, after running rampant in the East, has only recently begun to moderate its infestations as its natural pests have been established in its breeding areas.

Most plant pests have established a balance with their host in which a reasonable percentage of the plants or only a part of each plant is killed, but enough escape to propagate the species. This balance in nature is destroyed when men begin to cultivate crops in fields and orchard plantations and select plants for complete uniformity. If an insect or disease is introduced into such a plant community there is nothing to prevent it from attaining complete dominance within a few weeks or at most within a very few years.

Much has been written about the efficiency with which pests are controlled by quarantines, crop rotations, resistant or repellent varieties and use of miraculous new chemicals. One might deduce that plant disease and insect pests were perfectly controlled but an examination of the record shows that this is not so. The best estimates available indicate that plant diseases are still destroying produce valued at about two billion dollars annually and insects are about twice as destructive. It is well established that if no control measures were being applied, some of our more important crops could not be grown economically. The proper perspective to assume is that we have not controlled plant pests completely; we have merely learned to live with them.

The extent of current losses from pests is still a matter of estimation since there are no infallible methods of measuring destruction. By comparing yields in different seasons when pests are present or absent or by comparing treated and untreated plots in the same field, fair estimates can be obtained of the damage from infestation. Some data are inadequate as shown by the post-war experience with new insecticides on potatoes.

Flea beetles, Colorado potato beetles, and leafhoppers were known to cause extensive damage by foliage feeding. The mechanical injury from chewing by the two beetles was rather easily estimated but damage from the leafhoppers which caused severe tip burn while sucking out juices had been underestimated. The extent of the leafhopper injury was suggested many years ago when it was found that Bordeaux mixture, applied to control fungus leaf blights, often increased the yields substantially by repelling leafhoppers.

When DDT was introduced in 1945, even the horticulturists and entomologists were amazed at the yield increases obtained from controlling leafhoppers and other potato insects. Whereas a yield of 300 bushels per acre in the better potato-growing areas of Long Island had been considered good, yields of 400 to 450 bushels became fairly common. Some investigators

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even talked about the stimulatory effects of DDT because leaves were so large, dark green, and persisted so long when free of insect attack. The records show that potato yields in the United States have been increased 99% in less than two decades. Most of this has been due to use of better insecticides and milder fungicides although improved fertilizers and new varieties have contributed to the development.

## PEST CONTROL WITHOUT CHEMICALS

The preferred method of controlling pests is to avoid them. Tremendous expense has been incurred in mapping their geographic distribution, their local preferences, and in determining what climatic conditions control their destructiveness. Much has been achieved at nominal expense by placing crops in disease-free areas, on farms that have favorable histories and in adjusting planting dates to avoid certain weather conditions.

Established pests often may be suppressed by suitable culture practices. Rotation of crops to starve out the pests or alternate planting of repellent and suppressive crops is practiced regularly. Many soil pathogens are reduced by plowing under cover crops.

Quarantines are often imposed but they rarely do more than delay infestation of new areas. Pests have very little respect for man-made laws or artificial barriers.

The use of resistant or pest-escaping varieties has been of inestimable value in the struggle against pests. The achievements in grain, fiber, and some vegetable crops are well known. Less well recognized, however, is the hazard from use of hybrid crops bred to uniform standards of performance. Every plant in a field is so similar to its neighbors that once a parasite becomes established it spreads like wildfire throughout the area.

Even resistant varieties are a hazard because new races of fungi, bacteria, etc. are constantly evolving. A new race of a parasitic fungus may appear within a fortnight and become generally distributed within a couple of months. Scientists need about 10 years to breed a new variety, multiply its seed and get it into commercial production. The records show that new physiological races of crown rust on oats have forced the abandonment of outstanding new rust-resistant varieties 3 times in the past 2 decades and the plant breeders are now fighting against time to overcome the latest development. There have been 3 major varietal changes in wheat enforced by black stem rust in the past 3 decades. The most enduring disease-resistant crop has been the Martha Washington asparagus; but within the past year rust became severe on it either because a new race of rust has appeared or the varietal purity has been lost.

Although breeding of resistant varieties is the most convenient and economical method of controlling pests, it is not a complete answer. In addition to the pest's versatility, there are some plant parasites and a large percentage of the insect pests which attack all varieties indiscriminately. It has not been possible to breed resistant varieties that combine the preferred flavor, horticultural characteristics, etc. of many crops. Furthermore, it is not feasible to change varieties of fruit trees and many other perennials every few years.

Unfortunately, the vegetables and fruits which are consumed as raw products or after brief processing are most often attacked by pests that must be controlled by chemicals. The consumer insists that apples must be free of both scab and codling moth damage. Tomato juice cannot be sold legally if mould is present as a result of fruit infection from any one of 4 major disease fungi. The cast skins of aphids on spinach render it unfit for human consumption, according to the pure food and drug laws. These and several thousand other pests of fruit and vegetables must be controlled by chemicals when all other practical means have been exhausted.

How essential are these spray treatments? What would happen if all fungicides, insecticides, miticides, etc. were omitted from crop production practices? No one knows for certain because extensive experiments have not been made, but enough authentic records are available on several diseases of fruits and vegetables to be indicative so they may be reviewed in some detail.

## THE LATE BLIGHT OF TOMATOES

The late blight of potatoes (caused by *Phytophthora infestans*) has certain specialized races that attack tomato. These races, however, must return to the potato tuber in order to overwinter and consequently were not so prevalent as the regular strains prior to 1940. The disease occurred sporadically on farms such as those in the Finger Lakes area of New York where potatoes and tomatoes were grown intensively in adjacent fields. Control measures were developed for this and other diseases of tomatoes but farmers preferred to gamble that serious losses would not be experienced. During the period 1940-1945 the tomato strain of the fungus increased in prevalence. In 1946, weather conditions along the Atlantic seaboard were favorable to the development of the fungus. It became established in Florida during May and swept northward as the season progressed. Entire fields were wiped out. Losses of more than 50% were experienced in Florida, Georgia, the Carolinas, Virginia, Maryland, New York, Pennsylvania, and Massachusetts (Figure 1). It is the best documented record in modern times of an epidemic running wild without being retarded by control measures.

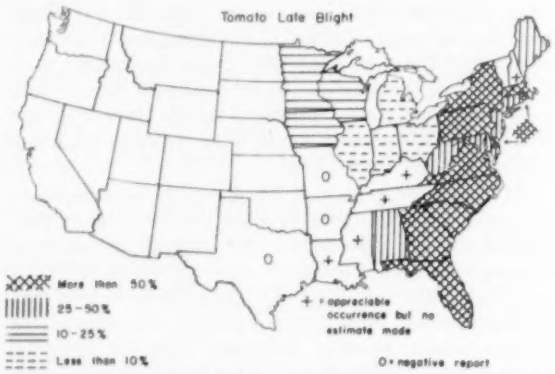


**Figure 1. Loss from late blight on tomatoes during the 1946 epiphytotic. Canning factories were forced to close on a wholesale scale and the market prices of tomatoes skyrocketed.**

In a few areas such as Delaware where a regular spray program consisting of 4 or 5 applications of basic copper sulfate were being used, losses were kept at a low level. Elsewhere the damage almost ruined the industry. Prices increased from $1.50 to several dollars a bushel in some areas. Canneries closed because of low volume of deliveries, high prices, and high mould count in the finished product. In spite of the closest possible grading and trimming, enough fungus mycelium was processed to render tomato juice and paste unacceptable under regulations of the Food and Drug Administration.

The long-range effect of this outbreak on tomato culture is interesting to follow. Careful records obtained in Pennsylvania showed that yields dropped from a mean of 5.4 tons per acre to 2.7 tons. Farmers who had been setting 34,200 acres of tomatoes were so discouraged that only 27,900 acres were set out in 1947 but 60% initiated spraying programs. The extra cost of operations suppressed the acreage to 19,400 in 1948 even though yields exceeded those prior to the 1946 outbreak. By 1949 only 20,500 acres were assigned to tomatoes, 85% were sprayed, and yields averaged 6.5 tons per acre. From this point the acreage has gradually begun to build back up, but the cost of tomatoes to the canner and consumer probably will be $2 to $3 a ton more than before the disease became severe, because of the cost of spraying.

Authorities in Pennsylvania have admitted that tomato processing might have been driven from their state had not control measures been immediately available. They estimate that produce valued at over 4 million dollars was saved by spraying 25 to 75% of the acreage in the 3 years following the outbreak.

The annual damage to potatoes from blight (Figure 2) where spraying is practiced more or less regularly fluctuates with the season. The available data for the period 1920-1939 show that the losses average only 3.3% but extreme fluctuations range

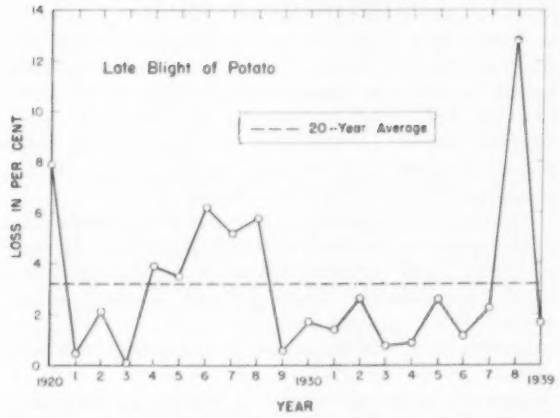


**Figure 2. Annual loss of potatoes from late blight in the United States as reported by collaborating scientists to the Plant Disease Survey. Severe losses may still occur in spite of well developed control measures.**

from the statistically insignificant loss of 1923 to about 13% in 1938. These losses occur in spite of spray treatments. They are probably attributable to the carelessness in applying fungicides where disease is severe following 2 or 3 moderate infestations.

## APPLE SCAB

Another example of a disease controlled by spraying is apple scab. As shown in Figures 3 and 4, there are 5 important diseases of apples. Annual losses over a 20-year period have averaged about 1% or less each for rust, bitter rot, black rot, and fireblight but scab averaged 5.6%. Apple scab fluctuated between 1% and 13%. In case this figure seems inconsequential, it amounted to 10,450,750 bushels of fruit, or about $10,555,000 each year. Black rot, during the same period, destroyed 1,247,000 bushels of fruit per annum.

These losses are all the more serious because they are often concentrated in a few areas. In Figure 5, the losses from scab are shown to be most severe in Maine, Pennsylvania, Wisconsin, and Kentucky but relatively light in one of the principal apple-growing areas, namely that of Washington, over a 20-year period. It is well to compare the impact of this disease in Pennsylvania where it is consistently severe and in Washington where it is relatively mild.

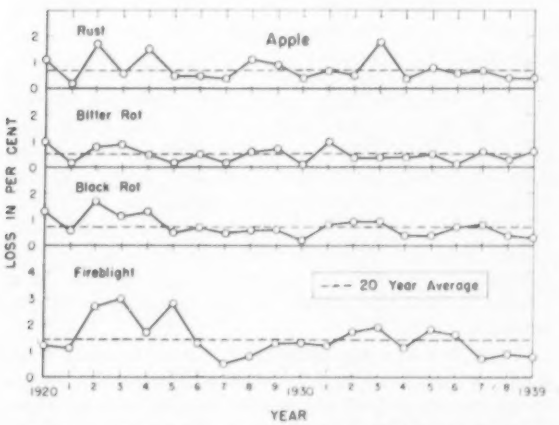


**Figure 3. Average annual loss in the United States from four important diseases of apples as reported by state specialists collaborating with the Plant Disease Survey. It will be noted that heavy losses do not occur from all diseases in the same years. This is because the causal agents have different methods of overwintering and attacking the apple, they respond differently to the seasonal fluctuations of weather, and some of them are somewhat regional in their occurrence so local weather conditions may drastically affect their destructiveness.**

The annual loss due to scabby fruit in Pennsylvania is only one factor. Dr. Kirby and his coworkers kept records on sprayed and unsprayed trees in the same orchard for several years. Yields from the unsprayed trees declined so that, at the end of the experiment, trees averaged only 2.3 bushels as compared to 11.3 bushels from properly sprayed trees. The vitality of the trees had been steadily lowered by defoliation where leaves were not protected and many branches had been winter-killed. A second benefit from spraying is the prevention of fruit drop. They found 26% of the blossoms on sprayed trees produced fruit while as little as .06% of the blossoms on unsprayed trees were productive.

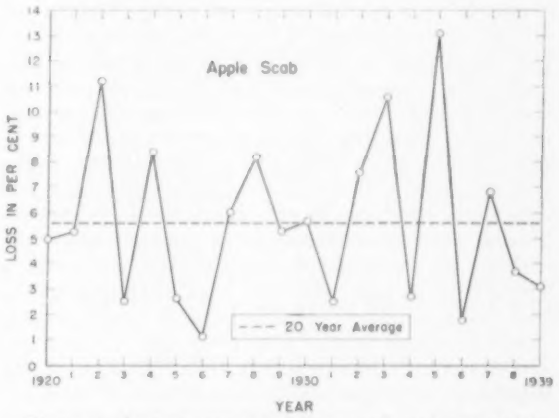


**Figure 4. Average annual loss from apple scab reported by collaborators of the Plant Disease Survey.**

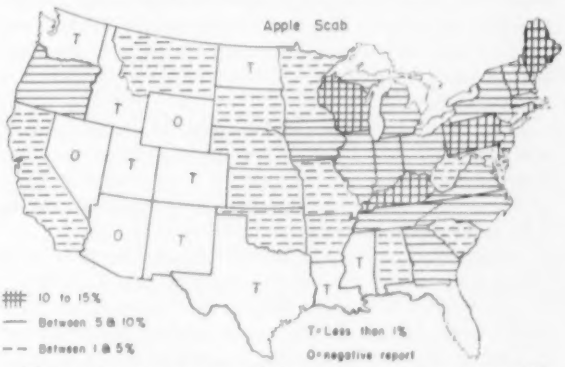


**Figure 5. Average annual loss from apple scab for the 20-year period 1920-1939, as estimated by collaborators of the Plant Disease Survey.**

The direct losses of fruit from scab infection were ascertained by a careful survey of orchards receiving different spray treatments in 1938. Unsprayed orchards (50 examined) had 82.4% scabby fruit while 241 incompletely sprayed ones had 10.8%. In the 107 orchards sprayed according to preferred practices, only 1.4% of the fruit was injured.

Even in Washington State where, according to the statistics, scab is of secondary importance, severe damage does occur. Records are available of farms being lost because of the financial liability incurred by scab. It is a threat to every unwary grower.

## ECONOMICS OF PROTECTING CROPS

The economic significance of any pest invasion can be better understood by examining the cost structure in an annual crop such as tomatoes. A careful survey made by the Agricultural Economists at Cornell on

some 24 outstanding farms in 3 major tomato-producing counties of upstate New York during 1951 showed that tomatoes were distinctly profitable. The cost of producing tomatoes was $170 and of harvesting them $193. From an investment of $363 a gross return of $596 was obtained. This amounted to $5.98 per hour of labor and left the farmers a profit of $233.

These farms are not typical since they averaged 18.1 tons per acre as compared to 9 tons for the entire state; so this is an abnormal margin of profit. Needless to say, this type of farmer took out crop insurance on his $170 investment in the form of a regular spray program. This insurance cost him $12.30 per acre for chemicals and $11.19 for labor (3 man hours) and equipment. Spraying was done almost entirely to control plant diseases. Without this insurance what might have happened? There are 3 serious foliage blights and 2 fruit rots which can be very destructive in their areas. Had early blight *(Alternaria)* or Septoria late blight occurred in a field with a potential yield of 18 tons, a loss of 4 to 10 tons could have been anticipated with 5 tons being a rather common loss. A profit of $233 would have been reduced to less than $80. If late blight *(Phytophthora)* had appeared, losses of 20 to 100% could have been sustained because of fruit infection and leaf blight. If more than 10% anthracnose infection occurred, the processing company probably would reject the crop because of high mould content in the processed material. The loss to the farmer in this case includes not only production costs but some of the harvest expense. There are several other fruit rots in this same category.

Fortunately, this formidable array of parasites does not occur extensively in destructive proportions each year. About 2 seasons out of 4 or 5 favor one or more of them. Nevertheless, they are a constant threat to safe, economical production of this crop.

Similar statistics can be quoted for potatoes, peas, snap beans, sweet corn, etc. where fungicides and insecticides are used. The better pea grower, for example, in these same areas invests $71.52 in producing the crop and $25.40 in harvesting it. The margin of profit is small and an infestation of pea aphids in June may cause a loss of half to two-thirds of the investment. Sweet corn may be raised for $42.61 and harvested for $17.58 per acre. The gross return from an investment of $60.19 is only $66.24 or $2.04 per man hour of labor. If 10% loss is experienced from borer or ear worm there would be no profit.

## AVOIDING RESIDUES ON AGRICULTURAL PRODUCE

Since it is obvious that various fruit and vegetable crops will have to be protected by pesticides, the basic question is how to use them with a minimum of hazard to the consumer. Fortunately, several procedures that can be employed to avoid excessive residues have been developed in recent years primarily because of the effectiveness of some of the new organic pesticides.

Spray schedules can be developed so very little, if any, spray materials have to be applied immediately prior to harvest. Peach leaf curl, for example, can be controlled by a single thorough application of fungicide while the tree is dormant. Apple scab control depends largely upon proper timing and thorough spraying before the fruit is set and during the immediate post-blossom period. A thorough program during these periods permits less frequent spraying and lighter dosages during late July and August.

Systematic studies of pest infestations and their relation to weather conditions have permitted many farmers to curtail spray and dust operations or to omit many of the applications. Eradicant and dormant sprays applied to the ground and trees before growth starts have come to be the major line of defense against many pests.

Late season and pre-harvest sprays can be used safely by employing non-persistent or relatively non-toxic materials. Among the more toxic insecticides, volatile materials such as nicotine sulfate and chemically unstable compounds such as the organic phosphates can be used safely if only a few simple precautions are observed. An appreciable volume of literature on persistence of deposits is accumulating to guide agriculturists in safe use of pesticides. The major problem in delivering high quality, safe farm products is one of education in many instances.

The necessity for excessive deposits of pesticides can be avoided by proper formulation. Fungicides may be used at one-half to one-quarter of the conventional dosages if the particles are ground to uniformly small size. By choice of proper particle size, the persistence of the materials on fruit and foliage may be regulated within definite specifications. Another means of regulating the density and persistence of pesticide deposits is the addition of dispersing agents, adhesives and deposit building adjuvants to them. These are fertile fields for additional research on all aspects of formulation but enough is known to be of great help to the manufacturer of fungicides and insecticides.

## SUMMARY

Extensive attempts to control pests by breeding of new varieties, seeking pest-free areas, imposing quarantines, changing crop culture practices, and using pest-escaping tactics have proved inadequate on many crops. The use of carefully chosen chemicals to control insects, fungi, bacteria, nematodes, and weeds has become an absolute necessity. The basic problem is to find materials that are relatively inocuous to warm-blooded animals or else can be applied in such fashion as to present a minimum hazard to the consumer of treated produce.

There is every reason to believe from the data available that pests can be controlled without undue hazard to the consumer by the measures outlined above. There is need for more and better pesticides to permit development of safe spray schedules. The new organics have been invaluable in this connection and further exploitation of their unique properties should solve many of the residue problems.

# Low Temperature Organisms in Frozen Vegetables[a]

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**The numbers and types of organisms found in frozen vegetables stored over long periods of time are described. The presence of types which grow at 32° F. (0° C.) through two years of storage or longer was given attention. The predominating type was found to be Gram-negative rod, resembling the Flavobacterium estereoromaticum types.**

The presence of appreciable numbers of organisms in frozen vegetables after storage for periods of two years or longer at 32° F. (0° C.) brings into bold relief the question of their possible significance. No conclusive data are available to indicate that obligate psychrophilic types might not be present in stored frozen vegetables or that facultative psychrophils may not develop if temperatures are raised to 32° F. (0° C.) or above and held for a sufficient period of time to allow growth. The survival of organisms in commercially stored frozen vegetables and the ability of such types to grow at freezing temperatures (32° F.-0° C.), although distinct questions, are nevertheless closely related under practical operating conditions.

That organisms will develop at low, 32° F. (0° C.) to 35° F. (1.6° C.) temperatures has been reported in many related fields. Förster *(3)* and Fischer *(2)* first reported such types in soil, Glage *(4)* noted them in meat, Müller *(6)* from milk and Rogers and Gray *(7)* from butter. Stiles and Pennington *(8)* reported an increase in the number of organisms in ice cream stored at 14° F. (—10° C.) to —4° F. (—20° C.). The literature in this field has been reviewed recently by Watrous, Dean, and Josephson *(9)*. The discussions on this subject, however, have not been too conclusive in regard to the presence and possible numbers of low temperature growing organisms in frozen vegetables.

It has been established by innumerable investigators that organisms survive the processes of commercial freezing of vegetables. Hucker, Brooks and Emery *(5)* reviewed the literature on this problem and have shown that the percentage of survival of organisms in peas, beans and corn, shows a general decrease in proportion to the number present when these vegetables are placed in frozen storage (0° F.-17.7° C.).

The objective of the current studies was to determine the numbers and types of organisms in frozen vegetables stored over long periods as well as the presence of types which grow at 32° F. (0° C.).

## METHODS

One hundred and ninety-five samples of frozen vegetables were examined of which 96 had been held in freezer storage (0° F.-17.7° C.) for 5 years or longer. Two hundred and eighty organisms were isolated for observation and general characterization. These samples were studied for the presence of freeze resistant organisms as well as the possible presence of psychrophilic types.

The presence of psychrophilic types could not, in all cases, be adequately determined by direct plating and incubation of the plates at the low temperatures desired. Samples to be examined for the presence of psychrophiles, in most instances, were held for 25 to 30 days at 32° F. (0° C.) prior to plating. In some cases, as required, the samples thus being held were added to tryptone-yeast extract broth prior to this low temperature holding. This holding at low temperatures prior to plating is particularly significant in those instances in which sources of potential psychrophils are being sought.

As a plating medium tryptone-yeast extract agar was used. The plates were generally incubated at 89.6° F. (32° C.) for 48 hours and duplicate plates at 32° F. (0° C.) for 28-31 days. The low temperature in all cases was maintained in an iced water bath held in a 34° F. (1.1° C.) constant temperature room.

In the discussion below, obligate psychrophils are considered to be those organisms which grew at 32° F. (0° C.) and not at 89.6° F. (32° C.) and facultative psychrophils the strains which grew both at 32° F. (0° C.) and 89.6° F. (32° C.).

## RESULTS AND DISCUSSION

**Number of organisms surviving after prolonged storage at 0° F. (—17.7° C.).** A base freeze resistant flora was present in the 96 samples of snap beans and lima beans which seemed to persist even after 10 years' storage at 0° F. (—17.7° C.) as shown in Table 1.

TABLE 1

**The number of organisms surviving in beans after prolonged storage at 0° F. (—17.7° C.)**

| Years storage at 0° F. | Number of samples | Average number of colonies per gram | | | | | |
|---|---|---|---|---|---|---|---|
| | | Rinse count | | | Disintegration count | | |
| | | 89.6° F. (32° C.) | 68° F. (20° C.) | 34° F. (1.1° C.) | 89.6° F. (32° C.) | 68° F. (20° C.) | 34° F. (1.1° C.) |
| 5[b] | 62 | 10,800 | 15,700 | 3,400 | 21,000 | 45,200 | 8,600 |
| 10[b] | 12 | 14,000 | 16,900 | 2,700 | 31,500 | 27,620 | 8,000 |
| 11[c] | 12 | 22,000 | 31,000 | ..... | 29,000 | 42,000 | ..... |

[b] = Snap beans.
[c] = Lima beans.

The presence of such a freeze resistant flora has been shown by Hucker, Brooks and Emery *(5)* in peas, beans and corn which were observed after 2 years' storage at 0° F. (—17.7° C.).

As might be anticipated, total counts made from disintegrated samples were significantly higher than rinse counts. The temperature at which the plates were incubated also indicated generally that the maximum count was obtained when plates were incubated at 68° F. (20° C.) for 4 days.

**Presence of facultative psychrophilic organisms in frozen vegetables.** It can be seen in Table 1 that both snap beans and lima beans contained a significant number of organisms which grew or remained viable at 0° F. (—17.7° C.) for 5 to 10 years. To determine more definitely the presence of psychrophils in frozen vegetables a separate series of ninety-nine samples were examined, using in this instance temperatures of incubation of the plates of 68° F. (20° C.) for 4 days or 32° F. (0° C.) for 31 days. Examinations were made

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both before and after the series of frozen vegetables were held at 32° F. (0° C.) for 31 days.

Observations on these 99 samples of commercially frozen vegetables with an unknown freezer storage period, showed an appreciable number of organisms capable of developing at 68° F. (20° C.) as indicated in Table 2. The number of psychrophils present in

**TABLE 2**
**Effect of holding (31 days) at 32° F. (0° C.) on growth of organisms in frozen vegetables**

| Vegetables | Number of samples | Average number of organisms per gram | | | |
|---|---|---|---|---|---|
| | | Before holding | | After holding | |
| | | Colony counts at | | Colony counts at | |
| | | 68° F. (20° C.) for 4 days | 32° F. (0° C.) for 31 days | 68° F. (20° C.) for 4 days | 32° F. (0° C.) for 31 days |
| Squash | 12 | 58,000 | 230 | 64,000 | 270 |
| Corn | 13 | 412,000 | 300 | 818,000 | 440 |
| Peas | 24 | 25,000 | 170 | 150,000 | 470 |
| Snap beans | 21 | 37,400 | 380 | 132,000 | 250 |
| Asparagus | 9 | 193,000 | 640 | 1,236,000 | 110,000 |
| Broccoli | 9 | 270,000 | 1,200 | 560,000 | 110,000 |
| Brussels sprouts | 8 | 109,000 | 370 | 1,016,000 | 64,000 |
| Cauliflower | 3 | 285,000 | 2,700 | 1,336,000 | 15,000 |

direct plating was relatively low with the possible exception of those obtained from the leafy vegetable types, i.e., asparagus, broccoli and cauliflower. After holding the vegetables for 31 days significantly higher counts were noted at 68° F. (20° C.), especially in the case of asparagus, broccoli, brussels sprouts and cauliflower. However the increase in the number of types which might be considered as obligate psychrophils, i.e., those which developed on the plates incubated at 32° F. (0° C.), but not at 68° F. (20° C.), was not significant. No increase of numbers of these types were noted in peas, corn, and snap beans but slight increases in count were noted in asparagus, broccoli and brussels sprouts using 32° F. (0° C.), as incubation temperatures for the plates.

There was present on the leafy type vegetables a significant flora of organisms which, although having an optimum growth temperature of 68° F. (20° C.), will develop, when held for extended periods, at 32° F. (0° C.). It should be noted that asparagus, broccoli, brussels sprouts and cauliflower are types of vegetables which may be contaminated readily by soil prior to reaching the plant and liberal routine washing is required, to free the vegetables from all the contamination. The presence of a flora capable of developing at 32° F. (0° C.) may not be inherent to these particular vegetables but rather comes from the soil or the wash water used by necessity in the adequate washing of this type of vegetable.

**Possible source of psychrophils in frozen vegetables.** All frozen vegetables may have sugar or salt added as a normal ingredient both of which might well be sources of low temperatures types. The direct examination of these ingredients by plating and incubating the plates at 32° F. (0° C.) for 30 days did not indicate the presence of an appreciable number of low temperature growing types. In order to determine if the small number of organisms present were psychrophils, 5 g. of the ingredient (salt, sugar) were dissolved in 500 cc. broth and then held at 32° F. (0° C.) for 30 days. A survey of 13 samples of salt and sugar collected from commercial freezing plants (Table 3) showed an insignificant number of organisms capable of developing at 32° F. (0° C.).

**TABLE 3**
**Effect of holding at 32° F. (0° C.) on growth of organisms in ingredients of frozen vegetables**

| Ingredient | Number of samples | Average number of organisms per gram (cc.) after holding in broth culture at 32° F. (0° C.) for | | |
|---|---|---|---|---|
| | | 0 days | 5 days | 30 days |
| Sugar | 5 | 250[a] | 200 | 310 |
| Salt | 5 | 200 | 300 | 650 |
| Brine | 3 | 500 | 200 | 400 |

[a] Colony counts at 68° F. for 48 hours.

A series of 25 samples of air, soil and water collected in or adjacent to vegetable freezing plants were examined as possible sources of psychrophils. Two g. of soil or 10 cc. of water were added to 500 cc. of tryptone-yeast extract broth and held for 30 days at 32° F. (0° C.). As may be noted in Table 4, the samples of soil and water contained a significant number of organisms capable of growing at 32° F. (0° C.). These types were not obligate psychrophils since an incubation temperature of 68° F. (20° C.) was used for the colony count. Three samples of air (1 cu. liter bubbled through 500 cc. broth) secured from 3 plants indicated that air contamination is not an important contaminating factor, for psychrophils in vegetable freezing plants.

**TABLE 4**
**Effect of holding at 32° F. (0° C.) on growth of organisms in potential sources of contamination of frozen vegetables**

| Source | Number of samples | Average number of organisms per gram (cc.) after holding in broth culture at 32° F. (0° C.) for | | |
|---|---|---|---|---|
| | | 0 days | 5 days | 30 days |
| Soil | 6 | 41,000[a] | 2,281,000 | 190,000,000 |
| Air | 3 | 300 | 300 | 400 |
| Gravel | 3 | 21,000 | 52,000 | 132,000,000 |
| Water | 5 | 600 | 1,000 | 595,000,000 |
| Water, deep well | 2 | 100 | 1,700 | 182,000,000 |
| Water, spring | 3 | 150 | ..... | 200 |
| Water, creek | 3 | 11,000 | 32,000 | 11,000,000 |

[a] = Colony counts at 68° F. (20° C.) for 4 days.

Water may be more significant than soil, as a source of low temperature growing types. All samples of water, except three, when added to broth and held at 32° F. (0° C.) for 30 days showed facultative psychrophilic organisms present. Three samples of gravel, two from creek beds and one deep from a glacial deposited gravel pit showed similar results. In 3 samples of spring water being used in one plant, no low temperature growing types were found (Table 4).

These results bring into bold relief the significance of efficient washing procedures in vegetable freezing plants and also the importance of a water supply free from psychrophilic organisms.

**Types of organisms in frozen vegetables.** Two hundred and sixteen cultures were isolated from peas, snap beans, corn and lima beans which had been held at 0° F. (—17.7° C.) for 2 to 10 years. These were isolated from plates using incubation temperature of

89.6° F. (32° C.) for 48 hours. These strains (Table 5) were of 2 general types, viz., paired cocci and Gram-negative rods.

Forty-three of the 55 strains of Gram-negative rods were almost identical in characteristics and culturally probably are of a type similar to *Flavobacterium esteroaromaticum* (Omelianski) Bergey *et al.* However, in these cultures no trace of the recorded fruity aroma characteristic of this type, was noted. The remaining 12 strains were *Achromobacter* sp.

Of the remaining strains isolated from plates incubated at 89.6° F. (32° C.), all were paired cocci. These strains showed many characteristics in common. They retained the Gram stain with difficulty and might be considered as Gram variable; all occurred as paired cocci, usually with slightly flattened edges where the cells were adjacent giving a paired "biscuit" appearance and all were relatively inactive on gelatin, litmus milk and in the production of acid. Some of the strains produced a faint yellow pigment on agar, while the remaining showed a profuse white growth. This type of coccus has been observed many times in frozen and other food products. In many respects these strains resemble species of *Micrococcus* although the characteristic paired nature of the cells is a character not generally encountered among the micrococci. If subsequent studies indicate that saprophytic types of the parasitic Gram-negative paired cocci are generally encountered, these strains may be considered as saprophytic species of the genus *Neisseria*.

In addition to the 216 strains isolated from frozen vegetables using 89.6° F. (32° C.) as the incubation temperatures for the plates as indicated in Table 5, 12 cultures were isolated from lima beans which had been held at 0° F. (—17.7° C.) for 10 years, using 32° F. (0° C.) as the incubation temperature for the plates. Of these 12 strains, two were yeasts and 10 were Gram-negative, yellow pigment producing rods. These 10 strains reduced nitrates, generally did not liquefy gelatin and were relatively inactive in fermentative abilities. They were similar to the *Flavobacterium estereoromaticum* types, as shown in Table 5. These 12 strains also grew at 89.6° F. (32° C.) which indicated that they were facultative and not obligate psychrophils.

It should be noted in Table 5 that 43 strains were isolated from these same lima beans using incubation of 89.6° F. (32° C.) for the plates and all were of the paired coccus type.

Fifty-two strains were isolated. Samples of peas and snap beans held at 32° F. (0° C.) for 28 days were plates and the plates incubaed at 32° F. (0° C.) for 31 days. Three of these grew at 89.6° F. (32° C.) and were of the paired biscuit coccus type and appeared identical with similar strains shown in Table 5. Forty-

**TABLE 5**

**Characters of strains isolated from vegetables stored for two or more years at 32° F. (0° C.) Plates incubated at 89.6° F. (32° C.) for 48 hours**

| Source | Number of strains | Number of strains showing positive reaction in | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Nitrate | Gelatin | Litmus milk: Acid | Litmus milk: Alkali | Litmus milk: Peptonization | Lactose | Glucose | Sucrose | Xylose | Mannitol | Arabinose | Maltose |
| Large Gram + White. Paired "biscuit" coccus. | | | | | | | | | | | | | |
| Peas, 2 years | 5 | 2 | 1 | 0 | 0 | 0 | 2 | 4 | 2 | 3 | 0 | 4 | 3 |
| Beans, 5 years | 31 | 28 | 7 | 6 | 0 | 3 | 4 | 7 | 4 | 4 | 2 | 2 | 4 |
| Lima beans, 10 years | 12 | 10 | 0 | 4 | 0 | 0 | 6 | 6 | 5 | 4 | 2 | .... | 4 |
| Total | 48 | 40 | 8 | 10 | 0 | 3 | 12 | 13 | 11 | 11 | 4 | 6 | 11 |
| Large Gram + Yellow. Paired "biscuit" coccus. | | | | | | | | | | | | | |
| Peas, 2 years | 12 | 11 | 7 | 10 | 0 | 0 | 6 | 8 | 7 | 4 | 6 | 5 | 7 |
| Corn, 2 years | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| Total | 13 | 12 | 7 | 10 | 0 | 1 | 6 | 8 | 8 | 5 | 6 | 6 | 8 |
| Gram + White. Paired coccus. | | | | | | | | | | | | | |
| Peas, 2 years | 43 | 17 | 10 | 15 | 9 | 2 | 15 | 30 | 23 | 28 | 14 | 28 | 25 |
| Lima beans, 10 years | 4 | 1 | 0 | 1 | 0 | 0 | 0 | 4 | 1 | 1 | 0 | 0 | 2 |
| Lima beans, 10 years | 17 | 4 | 0 | 4 | 0 | 0 | 4 | 15 | 2 | 4 | 2 | 4 | 1 |
| Total | 64 | 22 | 10 | 20 | 9 | 2 | 19 | 49 | 26 | 33 | 16 | 32 | 28 |
| Gram + Yellow. Paired coccus. | | | | | | | | | | | | | |
| Peas, 2 years | 7 | 4 | 5 | 4 | 1 | 0 | 4 | 6 | 6 | 6 | 3 | 6 | 6 |
| Beans, 2 years | 8 | 7 | 3 | 4 | 1 | 1 | 4 | 6 | 7 | 4 | 6 | 2 | 5 |
| Corn, 2 years | 14 | 14 | 4 | 5 | 6 | 1 | 7 | 11 | 7 | 10 | 2 | 10 | 9 |
| Lima beans, 10 years | 7 | 7 | 6 | 6 | 0 | 0 | 3 | 6 | 5 | 3 | 2 | 2 | 3 |
| Total | 36 | 32 | 18 | 19 | 8 | 2 | 14 | 29 | 25 | 21 | 13 | 20 | 23 |
| Gram — White Short Rod. Achromobacter sp. | | | | | | | | | | | | | |
| Peas, 2 years | 9 | 0 | 0 | 1 | 4 | 0 | 4 | 6 | 6 | 6 | 3 | 6 | 5 |
| Beans, 5 years | 3 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 12 | 1 | 2 | 2 | 4 | 1 | 4 | 7 | 6 | 6 | 3 | 6 | 5 |
| Gram — Yellow Short Rod. Flavobacterium sp. | | | | | | | | | | | | | |
| Peas, 2 years | 27 | 1 | 26 | 0 | 0 | 27 | 0 | 27 | 3 | 1 | 0 | 6 | 26 |
| Beans, 2 years | 5 | 0 | 5 | 0 | 0 | 5 | 0 | 4 | 2 | 2 | 0 | 5 | 5 |
| Corn, 2 years | 3 | 0 | 3 | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 1 | 1 |
| Beans, 5 years | 5 | 0 | 5 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 1 |
| Peas, 5 years | 3 | 1 | 3 | 0 | 1 | 2 | 0 | 2 | 2 | 2 | 0 | 2 | 2 |
| Total | 43 | 2 | 42 | 0 | 1 | 40 | 0 | 38 | 7 | 5 | 0 | 14 | 35 |

nine of this series of strains were Gram-negative rods; all produced acid from dextrose but not from the other sources of carbon. Only a slight amount of acid was formed in litmus milk and generally nitrates were not reduced or gelatin liquefied. These strains, although obtained by holding the vegetables at 32° F. (0° C.) were not obligate psychrophils. They appeared identical with the *Flavobacterium estereoromaticum* type noted in Table 5.

## CONCLUSIONS

The presence of psychrophilic organisms in frozen vegetables, or possible sources of psychrophilic contamination, can best be determined by holding the sample at 32° F. (0° C.) for 30 days prior to plating with plates incubated subsequent to this holding, at 68° F. (20° C.) for 48 hours and 32° F. (0° C.) for 30 days.

Snap beans and lima beans were found to contain a significant base freeze resistant flora which remained viable after storage at 0° F. (—17.7° C.) for 2 to 10 years.

Facultative psychrophils were found in asparagus, brussels sprouts, broccoli and cauliflower but were not generally present in peas, squash, corn and snap beans. Obligate psychrophilic types were not encountered in any of the 195 samples of frozen vegetables studied.

Facultative psychrophils were not found in salt or sugar but were relatively common in samples of soil and water obtained in or adjacent to commercial freezing plants.

In frozen vegetables held at 0° F. (—17.7° C.) for two years or longer the predominating organism is a large, paired "biscuit" shaped coccus when the isolations were made from plates incubated at 89.6° F. (32° C.). When the isolations were made from plates incubated at 32° F. (0° C.) for 30 days, the predominating type was Gram-negative rod, resembling the *Flavobacterium estereoromaticum* types.

## LITERATURE CITED


1. Bergey, D. H., *et al. Manual of Determinative Bacteriology.* 3rd edition, 1930, Williams and Wilkins, Baltimore, Md.
2. Fischer, C. Bakterierwachstum bei 0° C. sowie über das Photographiren von Kulturen leuchtender Bakterien in ihrem eigenen Lickte. *Centralbl. f. Bakt.*, **4**, 89-92, 1888.
3. Forster, J. Ueber einige cigenschaften leuchtender Bakterien. *Centralbl. f. Bakt.*, **2**, 337-340, 1887.
4. Glage, E. Ueber die Bedeutung der Aromabakterien für die Fleischhygiene. *Zeitschr. f. Fleisch. v. Milchhygiene*, **11**, 131-138, 1901.
5. Hucker, G. J., Brooks, R. F., Emery, A. The source of bacteria in processing and their significance in frozen vegetables. *Food Technol.*, **6**, 147-155, 1952.
6. Müller, M. Ueber das Wachstein und die Lebenstatigkeit von Bakterien sowie den Ablauf fermentier progress bei niederer temperature unter spezieller Baruchsalitung des Fleisces als Nahrungamittel. *Arch. f. Hyg.*, **42**, 122-193, 1903.
7. Rogers, L. A., and Gray, C. E. Influence of the acidity of cream on the flavor of butter. U. S. Department Agric., Bur. An. Indus. *Bull.*, 1909.
8. Stiles, G. W., and Pennington, M. E. Changes in Ice Cream during Storage. U. S. Hyg. Lab. *Bull. 56*, 1909.
9. Watrous, G. H., Doan, F. S., and Josephson, D. V. Some bacteriological studies in refrigerated ice cream. Penn. State College *Bull. No. 151*, 1952.


# Effect of Oil Treating Shell Eggs on Their Functional Properties After Storage[a]


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**The functional and flavor properties of oil-treated shell eggs, stored for 2, 4, and 6 months, were studied. Cooking quality and flavor are compared to candled quality and the value of processing shell eggs with oil prior to storage is discussed.**


Use of light, tasteless, colorless mineral oil for preserving shell eggs is a common commercial practice. The process is not new. It was practiced as early as 1807 by the Dutch *(14)*. Much work has been done during the past two decades to improve methods and to check results of oil processing shell eggs. Funk *(5)* reviewed the literature regarding maintaining quality in shell eggs by oil treatment and other methods.

The cooking properties of eggs processed with mineral oil were investigated by McIntosh *et al. (8)* who studied the culinary quality of poached eggs and eggs cooked in the shell as well as the whipping properties of the egg white and pH of the yolk and white. In all cases, they found that oil processing of the shell improved keeping quality of the egg. In a similar study by Carlin and Foth *(2)* oil-treated shell eggs were compared with thermostabilized shell eggs with respect to their interior quality and functional properties.

The present paper reports data from a comprehensive study involving the cooking quality and flavor of eggs as related to candled quality and to various storage treatments. The value of processing shell eggs with oil prior to storage is considered.

## EXPERIMENTAL PROCEDURE

Eggs produced by 2 flocks of White Leghorn pullets from the same strain were used for this experiment. Flock 1 was fed ration I and flock 2 was fed ration II. The compositions of these diets are given in Table 1. The feeds were supplemented


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**TABLE 1**

**Ingredients used in experimental rations**

| Ingredient | Ration I | Ration II |
|---|---|---|
| | % | % |
| Ground yellow corn | 58.0 | ..... |
| Ground wheat | ..... | 35.0 |
| Ground barley | ..... | 15.0 |
| Ground oats | ..... | 12.5 |
| Wheat mixed feed | 15.0 | 20.0 |
| Dehydrated alfalfa meal | 10.0 | ..... |
| Soybean meal | 10.0 | 10.0 |
| Herring fish meal | 3.0 | 3.0 |
| Dicalcium phosphate | 3.0 | 3.0 |
| Salt (sodium chloride) | 0.5 | 0.5 |
| Vitamin A & D supplement, dry form (4000 I. U. vitamin A and 750 AOAC units vitamin D) | 0.5 | 1.0 |
| Manganese sulfate | 4 oz./ton | 4 oz./ton |

with a light feeding of scratch grain once each day, approximately an equal amount being fed to each flock along with oyster shell fed *ad libitum*. The principal reason for feeding scratch grain was to aid in litter management. All hens were trap nested, and identity of the egg was maintained by hen number and date of production. In this way, eggs from the same hens could be used throughout the study for each storage treatment. Group 1 eggs were collected and at the end of each day placed in a 32° F. (0° C.) cold room in wooden cases. Group 2 eggs were similarly collected and dipped in cold, light weight, mineral oil prior to putting them into 32° F. (0° C.) storage. Eggs from Group 3 were collected and placed in 55° F. (12.8° C.) storage for 7 days. They were then oiled and placed at 32° F. (0° C.). Samples were removed from storage at the end of 2, 4 and 6 months. After 6 months, 2 samples were removed, one being tested immediately and the other being held for 2 weeks at room temperatures varying from 70 to 88° F. (21.1 to 31.1° C.) during the 2-weeks period prior to being tested. Quality of individual eggs was determined by candling, according to U. S. quality specifications for individual eggs *(3)*, by broken-out quality as determined by Haugh units *(1)*, albumen index *(17)*, albumen score *(16)*, yolk index *(11)*, and yolk color *(7)*. The pH of pooled samples of albumen was determined by using a Beckmann pH meter with glass electrodes.

From each treatment group the eggs on which the above quality measurements were made, were used for preparation of angel food cakes and custards. Methods of preparation are given in detail by Sauter *et al. (10)*. Samples of eggs for poaching were also broken out and quality measurements made, with the exception of yolk index and pH, prior to their being poached. Candling was the only quality measurement of eggs cooked in the shell.

The quality of the angel food cakes was determined by volume, penetration test and by a taste panel for color, flavor, texture and grain, tenderness and general acceptability. A panel also evaluataed custards for flavor, texture and consistency. Poached and cooked in the shell egg quality was determined by a taste panel scoring flavor. Prior to judging experimental samples, judges were trained to recognize satisfactory and unsatisfactory products. The reliability of each taster was determined on known samples. Only individuals consistently scoring products within 10% of the average of all judges were used as panel members. Data from a fresh egg sample measured approximately the date the eggs were stored are presented for comparison.

## RESULTS AND DISCUSSION

The results of physical quality determination on individual eggs are presented in Table 2. The beneficial effects of oil treatments on maintaining albumen quality and yolk quality are apparent after 4 months' storage. The improvement from immediate oiling of shell eggs is much greater than that of oiling after 7 days' storage at 55° F. (12.8° C.). This would be expected because there is considerable quality loss during holding for one week at 55° F. (12.8° C.). These findings agree with those of Evans and Carver *(4)*. The yolk color increased as the eggs aged. This increase was especially evident during the first 2 months of storage. Such a change in color has been reported by Parker *(9)*.

The quality of shell eggs as determined by albumen indices, stored for 6 months at 32° F. (0° C.) was found to be comparable or superior to eggs held for one week at 72° F. (22.2° C.) *(16)*. With the immediate oil treatment of shells the eggs held for 6 months at 32° F. (0° C.) and then 2 weeks at room temperature (70 to 88° F., 21.1 to 31.1° C.) were comparable to similar eggs without shell treatment held for 2 months at 32° F. (0° C.).

The reciprocal relationship between $CO_2$ retention and pH change was reported by Sharp and Stewart *(12)*. Swenson *(15)* determined the relative rates of

**TABLE 2**

**Effect of oiling on egg quality as determined by candled quality and physical measurements on raw eggs**

| | Candled quality | | Albumen | | Yolk | | | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Haugh units | | Color | | Index | | | |
| Ration | I | II | I | II | I | II | I | II | I | II |
| Treatment of eggs | | | | | | | | | | |
| Fresh, day-old | A | AA | 91 | 94 | 13.3 | 5.0 | .40 | .40 | 8.3 | 8.4 |
| Untreated 32° F. (0° C.) | | | | | | | | | | |
| Age—2 mos. | A | AA | 82 | 81 | 14.8 | 6.9 | .38 | .39 | 8.5 | 8.7 |
| 4 mos. | A | A | 79 | 78 | 14.2 | 7.1 | .37 | .36 | 8.7 | 8.6 |
| 6 mos. | A | A | 72 | 75 | 14.0 | 6.8 | .34 | .36 | 8.7 | 8.7 |
| 6 mos. plus 2 weeks room temp.[a] | B | B | 61 | 59 | 14.5 | 6.2 | .29 | .24 | 9.1 | 9.1 |
| Regression [b] | | | —3.9 | —4.2 | +.09 | +.22 | —.01 | —.02 | +.10 | +.07 |
| Immediate oil 32° F. (0° C.) | | | | | | | | | | |
| Age—2 mos. | A | AA | 88 | 88 | 14.3 | 7.0 | .39 | .38 | 7.6 | 7.7 |
| 4 mos. | A | AA | 87 | 89 | 13.8 | 6.8 | .38 | .40 | 7.6 | 7.4 |
| 6 mos. | A | A | 83 | 81 | 14.4 | 6.7 | .36 | .39 | 8.0 | 7.6 |
| 6 mos. plus 2 weeks room temp.[a] | A | A | 81 | 81 | 14.4 | 6.6 | .35 | .37 | 7.9 | 7.7 |
| Regression [b] | | | —1.4 | —1.9 | +.14 | +.20 | —.01 | —.002 | —.03 | —.10 |
| 7 days 55° F. (12.8° C.) then oil and 32° F.(0° C.) | | | | | | | | | | |
| Age—2 mos. | A | AA | 79 | 79 | 14.5 | 6.9 | .38 | .37 | 8.6 | 8.6 |
| 4 mos. | A | A | 76 | 79 | 13.8 | 7.0 | .37 | .38 | 8.3 | 8.3 |
| 6 mos. | A | A | 74 | 71 | 14.1 | 7.3 | .37 | .38 | 8.2 | 8.1 |
| 6 mos. plus 2 weeks room temp.[a] | C | B | 61 | 69 | 14.5 | 6.8 | .31 | .31 | 8.2 | 8.3 |
| Regression [b] | | | —3.6 | —3.4 | +.11 | +.26 | —.02 | —.01 | —.03 | —.05 |

[a] Temperature of room varied from 70 to 88° F. (21.1 to 31.1° C.).

[b] Assuming straight line regression values indicate change per month.

$CO_2$ retention by oil-treated shell eggs. From data in Table 2, it is apparent that oil treatment of shell eggs inhibits $CO_2$ loss, thereby decreasing the pH values. Cold storage retards the rate of loss of $CO_2$ but has no effect on its loss when eggs are moved to room temperature 70 to 88° F. (21.1 to 31.1° C.). The effectiveness of oil treatment in inhibiting $CO_2$ loss as shown by pH measurements is apparent irrespective of storage temperature.

The data relating shell treatments and storage conditions of eggs to functional properties in angel food cakes are presented in Table 3. The volumes of angel food cakes made with untreated and oil treated eggs stored at 32° F. (0° C.) for up to 4 months were comparable to cakes made with fresh eggs. Oil treatment of shell eggs had no measurable effect on volumes of angel food cake made with them when compared with cakes made from untreated eggs but stored under identical conditions at 32° F. (0° C.). However, when eggs were removed from refrigeration after 6 months' storage and held for 2 weeks at rooms temperature (70 to 88° F., 21.1 to 31.1° C.), the volumes of cakes made from untreated eggs were considerably lower than volumes of those made from shell-treated eggs. Similar results were obtained with the penetrometer measurement for tenderness. The various characteristics measured by the panel of tasters seemed to follow the same pattern.

The only measurement of custards which differentiated among qualities of eggs (based on physical measurements) used in their preparation was consistency as determined by the taste panel. Data on custards are presented in Table 4.

The taste scores of poached eggs are listed in Table 5. There is some indication from these data that oil treating may increase the rate of development of off-flavors, maximum differences in regression values being —.32 for untreated and —.56 for oil treated eggs. McIntosh

**TABLE 3**

**Effect of oiling eggs on their functional properties, flavor and acceptability in angel food cakes**

| | Age of eggs | Quality Measurements on Angel Food Cakes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Volume ml. | Penetrometer mm. | Taste Panel Score [a] | | | | |
| | | | | Color | Flavor | Texture and grain | Tenderness | Acceptability |
| Ration | | | | | | | | |
| Treatment of eggs | | | | | | | | |
| Fresh | 1 day | 708 | 17.9 | 4.0 | 3.8 | 3.9 | 4.0 | 4.0 |
| Untreated 32° F. (0° C.) | 2 months | 732 | 16.9 | 3.9 | 3.8 | 3.7 | 3.8 | 3.8 |
| | 4 months | 695 | 15.2 | 4.0 | 3.9 | 4.0 | 4.0 | 3.9 |
| | 6 months | 682 | 20.0 | 4.2 | 3.8 | 3.9 | 4.0 | 3.8 |
| | 6½ months [f] | 518 | 8.6 | 2.9 | 1.9 | 2.1 | 2.4 | 1.9 |
| | Regression [b] | —21.4 | —6.9 | —.08 | —.17 | —.15 | —.14 | —.20 |
| Immediate oil 32° F. (0° C.) | 2 months | 732 | 18.8 | 4.0 | 4.1 | 3.8 | 4.1 | 3.8 |
| | 4 months | 708.0 | 18.2 | 4.0 | 3.8 | 3.9 | 4.1 | 3.8 |
| | 6 months | 678.0 | 17.8 | 4.3 | 3.3 | 3.8 | 3.4 | 3.3 |
| | 6½ months [f] | 635 | 18.1 | 4.1 | 1.4 | 3.7 | 3.8 | 2.8 |
| | Regression [b] | —14.3 | —.03 | —.02 | —.19 | —.016 | —.07 | —.20 |
| 7 days at 55° F. (12.8° C.) Oil 32° F. | 2 months | 700 | 14.3 | 3.6 | 3.7 | 3.4 | 1.4 | 3.8 |
| | 4 months | 702 | 15.4 | 4.0 | 3.6 | 3.3 | 3.9 | 3.6 |
| | 6 months | 600 | 16.7 | 3.5 | 2.8 | 3.0 | 3.3 | 2.8 |
| | 6½ months [f] | 571 | 14.6 | 4.0 | 2.4 | 2.8 | 2.8 | 2.4 |
| | Regression [b] | —20.8 | —22.0 | —.02 | —.21 | —.15 | —.16 | —.24 |

[f] Last 2 weeks' storage at room temperature (70-88° F., 21.1-31.1° C.).
[a] Maximum score for each observed characteristic was 5.
[b] Assuming straight line regression, values indicate change per month.

**TABLE 4**

**Effect of oiling eggs on their functional properties and flavor in custards**

| | Age of eggs | Quality measurements on custard | | | | | |
|---|---|---|---|---|---|---|---|
| | | Penetrometer reading mm. | Height mm. | | Taste panel score [f] | | |
| | | | Immediate | One hour | Texture | Consistency | Flavor |
| Ration | | | | | | | |
| Treatment of eggs | | | | | | | |
| Untreated 32° F. (0° C.) | 1 day | 29.7 | 30.1 | 18.5 | 4.9 | 4.8 | 4.9 |
| | 2 months | 30.5 | 28.7 | 20.0 | 5.0 | 4.8 | 4.9 |
| | 4 months | 27.2 | 30.6 | 27.6 | 4.9 | 5.0 | 4.6 |
| | 6 months | 29.3 | 32.4 | 28.5 | 4.8 | 4.4 | 4.1 |
| | 6½ months [f] | 32.2 | 29.6 | 17.2 | 4.5 | 2.3 | 2.8 |
| | Regression [b] | +.14 | +.22 | +.66 | +.06 | —.27 | —.27 |
| Immediate oil 32° F. (0° C.) | 2 months | 30.7 | 29.9 | 21.5 | 4.8 | 4.6 | 4.3 |
| | 4 months | 28.4 | 28.6 | 18.4 | 4.9 | 4.9 | 4.4 |
| | 6 months | 30.2 | 29.0 | 20.8 | 4.7 | 4.7 | 3.8 |
| | 6½ months [f] | 30.6 | 26.4 | 19.2 | 4.7 | 3.5 | 2.8 |
| | Regression [b] | +.06 | —.44 | +.08 | —.03 | —.13 | —.25 |
| 7 days at 55° F. (12.8° C.) Oil 32° F. | 2 months | 29.0 | 28.5 | 20.4 | 4.9 | 4.5 | 4.3 |
| | 4 months | 30.3 | 28.8 | 23.0 | 4.9 | 4.8 | 3.4 |
| | 6 months | 28.1 | 24.6 | 20.7 | 4.7 | 4.4 | 3.5 |
| | 6½ months [f] | 33.2 | 26.6 | 16.2 | 4.7 | 2.0 | 2.8 |
| | Regression [b] | +.25 | —.66 | —.11 | —.03 | —.28 | —.29 |

[f] Last 2 weeks' storage at room temperature (70-88° F., 21.1-31.1° C.).
[a] Maximum score for each observed characteristic was 5.
[b] Assuming straight line regression, values indicate change per month.

*et al. (8)* reported no detrimental flavor changes during storage due to oil treating shell eggs. The appearance of poached eggs as measured by cooked albumen index (Table 5) is a poor criterion for general acceptability.

**TABLE 5**

**Effect of oiling eggs on their quality and acceptability as poached eggs and eggs cooked in the shell**

| | Age of eggs | Poached eggs | | Eggs cooked in shell Flavor by taste panel |
|---|---|---|---|---|
| | | Cooked albumen index | Flavor by taste panel [m] | |
| Ration | | | | |
| Treatment of eggs | | | | |
| Fresh | 1 day | 221 | 4.4 | 4.5 |
| Untreated | 2 months | 233 | 4.3 | 4.0 |
| 32° F. (0° C.) | 4 months | 223 | 4.3 | 4.0 |
| | 6 months | 238 | 3.2 | 2.2 |
| | 6½ months [l] | 174 | 1.9 | 1.5 |
| | Regression [n] | —3.8 | —1.8 | —.44 |
| Immediate oil | 2 months | 236 | 4.4 | 4.3 |
| 32° F. (0° C.) | 4 months | 246 | 3.9 | 3.4 |
| | 6 months | 233 | 1.4 | 2.1 |
| | 6½ months [l] | 218 | 1.3 | 1.1 |
| | Regression [n] | —1.9 | —.56 | —.51 |
| 7 days at | 2 months | 237 | 4.3 | 4.2 |
| 55° F. (12.8° C.) | 4 months | 198 | 3.2 | 3.7 |
| Oil-32° F. | 6 months | 189 | 1.7 | 1.8 |
| | 6½ months [l] | 158 | 1.0 | 1.3 |
| | Regression [n] | —9.0 | —.55 | —.50 |

[l] Last 2 weeks' storage was at room temperature (70-88° F., 21.1-31.1° C.).

[m] Maximum score was 5.

[n] Assuming straight line regression, values indicate change per month.

This is especially evident with eggs oiled on the day laid and stored for 6 months 32° F. (0° C.) or those then removed for 2 weeks' holding at room temperature. The cooked albumen indices classed the eggs as fresh whereas the flavor score indicated they were undesirable.

The flavor scores of eggs cooked in the shell are listed in Table 5. The observed values agree with those reported by Slocum *et al. (13)*. The observation made by McIntosh *et al. (8)* that poached eggs are a more critical measure of flavor than those cooked in the shell was not confirmed in this study.

The ration fed had no significant effect on quality measurements of eggs, with the exception of candled quality and yolk color. Wilhelm and Heiman *(18)* reported that ingredients used in ration I would result in much darker yolk color than those of ration II. The effect of candled quality was entirely due to a more distinct yolk outline with dark yolk eggs. There were no significant variations with respect to functional properties and flavor in products prepared from eggs produced by hens fed the two diets.

## SUMMARY

Eggs were stored at 32° F. (0° C.) for 2, 4 and 6 months with a subsequent holding period of 2 weeks at room temperature (70-88° F., 21.1-31.1° C.). Eggs in 2 groups were treated with oil, one on the day laid and the other 7 days later (55° F., 12.8° C.) and then placed in cold storage. Similar eggs were placed in 32° F. (0° C.) storage on the day laid without shell treatment.

The quality of eggs was determined by candling, Haugh units, albumen index, albumen score, yolk index, yolk color and pH.

The functional and flavor properties were measured by using test eggs for the preparation of angel food cakes, custards, poached, and eggs cooked in the shell.

Quality and functional properties of eggs were maintained at a higher level with oil treatment of the shells on the day the eggs were laid than by the other methods. Oil treating shell eggs after holding for 7 days at 55° F. (12.8° C.) retarded quality loss of eggs but was not so satisfactory as the immediate oiling. The functional properties of eggs used for angel food cakes were maintained better during the final 2 weeks by this method than without shell treatment.

Oil treatment of shell eggs was of no value in maintaining flavor of eggs during storage.

## LITERATURE CITED

1. Brant, A. W., Otte, A. W., and Norris, K. H. Recommended standards for scoring and measuring opened egg quality. *Food Technol.*, **5**, 356 (1951).
2. Carlin, A. F., and Foth, J. Interior quality and functional properties of oiled and thermostabilized shell eggs before and after commercial storage. *Food Technol.*, **6**, 443 (1952).
3. Dice, G. A. U. S. standards, grades and weight classes for shell eggs. *Federal Register*, June 11, 1952.
4. Evans, R. J., and Carver, J. S. Shell treatment of eggs by oiling. I. Effect of time between production and oiling on interior quality of stored eggs. *U. S. Egg and Poultry Magazine*, **48**, 546 (1942).
5. Funk, E. M. Maintenance of quality in shell eggs by thermostabilization. Missouri Res. *Bull. 467* (1950).
6. Harns, J. V., Sauter, E. A., McLaren, B. A., and Stadelman, W. J. Relationship of shell egg quality and performance of egg white in angel food cakes. *Food Research*, **18**, 343 (1953).
7. Heiman, V., and Carver, J. S. The yolk color index. *U. S. Egg and Poultry Magazine*, **41** (8), 40 (1935).
8. McIntosh, J. A., Tanner, K., Evans, R. J., and Carver, J. S. Cooking properties of eggs processed in mineral oil. *U. S. Egg and Poultry Magazine*, **48**, 345 (1942).
9. Parker, S. L. Studies in egg quality. II. Seasonal variations in yolk color. *Poultry Sci.*, **6**, 259 (1927).
10. Sauter, E. A., Harnes, J. V., Stadelman, W. J., and McLaren, B. A. Relationship of candled quality of eggs to other quality measurements. *Poultry Sci.*, **32**, 850 (1953).
11. Sharp, P. F., and Powell, C. K. Decrease in interior quality in hen's eggs during storage as indicated by the yolk. *Ind. Eng. Chem.*, **22**, 908 (1930).
12. Sharp, P. F., and Stewart, G. F. Carbon dioxide and the keeping quality of eggs. *U. S. Egg and Poultry Magazine*, **37** (6), 30 (1931).
13. Slocum, R. R., Lee, A. R., Swenson, T. L., James, L. H. and Steinbarger, M. C. Study of egg flavor in stored oil treated eggs. *U. S. Egg and Poultry Magazine*, **39** (4), 14 (1933).
14. Spamer, C. O. Historic method and practice of preserving eggs in Holland. *U. S. Egg and Poultry Magazine*, **31** (2), 48 (1941).
15. Swenson, T. L. Storage of shell eggs. *Food Research*, **3**, 599 (1938).
16. Van Wagenen, H., and Wilgus, H. S., Jr. The determination and importance of the condition of the firm albumen in studies of egg white quality. *J. Agr. Res.*, **51**, 1129 (1935).
17. Wilhelm, L. A., and Heiman, V. Albumen index determination by nomogram. *U. S. Egg and Poultry Magazine*, **42**, 426 (1936).
18. Wilhelm, L. A., and Heiman, V. The effect on yolk color of various ingredients of poultry feeds. *Poultry Sci.*, **16**, 416 (1937).

# Determination of Free Galacturonic Acid in Citrus Products[a]

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**The range of galacturonic acid in citrus fruit of varying maturity is studied. A method of determining free galacturonic acid in citrus fruit, juices, and concentrates is described. Determinations of free galacturonic acid in California Valencia, navel, and lemon fruit and juice are reported.**

The presence of abnormal quantities of free galacturonic acid in fruit and vegetable products has been proposed as evidence of decomposition by microbial activity by Harris *(3)*. In citrus fruits internal decomposition is not always evident in the external appearance or texture of the fruit. Considerable quantities may be unintentionally accepted by experienced graders. If galacturonic acid concentration could be used as an index to this condition, the processor would have an objective basis for eliminating undesirable lots of fruit.

Methods for the determination of galacturonic acid have been proposed by Harris *(3)*, Winkler *(9, 10)*, Mills *(6, 7)* and Joslyn *et al. (4)*. All are based on the Tollens reaction of uronic acids with naphthoresorcinol. Other methods are discussed by Kertesz *(5)*. Preliminary studies led to the selection of features from the methods of Winkler and Mills for a modified procedure best suited for citrus products. Additional study led to the selection of the Mills technique for color development due to greater sensitivity (Figure 1). However,

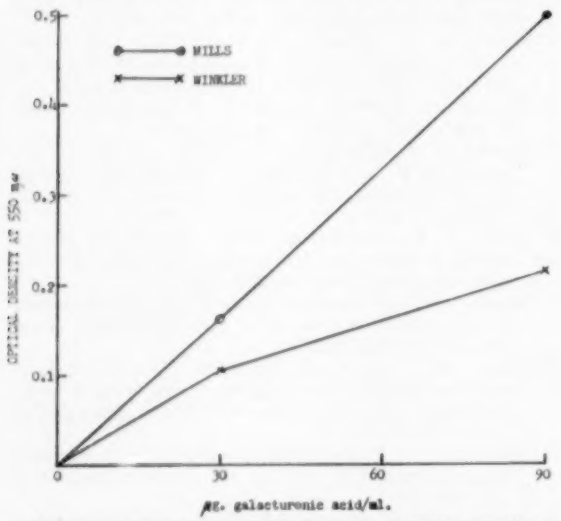


**Figure 1. Comparison of Winkler versus Mills procedures for determination of galacturonic acid.**

color intensities at galacturonic acid concentrations below 20 μg. per ml. were still in a range where relative error was large. A study of the rate of color development led to prolongation of the reaction time from 180 to 210 minutes (Figure 2).

[a] Presented at the Thirteenth Annual Meeting of the IFT, June 22, 1953, Boston, Massachusetts.

Although extension of the reaction time improved the accuracy of the method, the relative error at low concentrations was undesirably great. In order to increase the sensitivity at low concentrations, it was necessary to establish two standard curves; one for the range

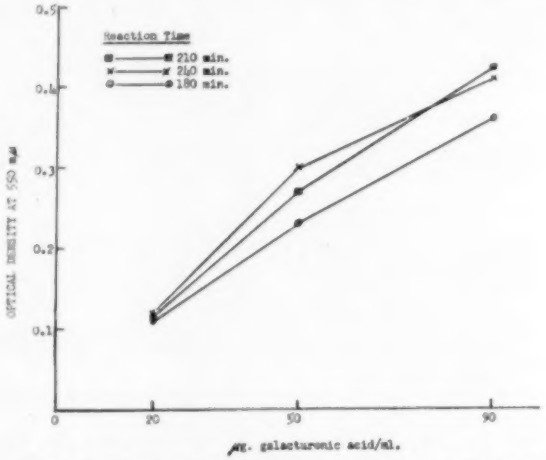


**Figure 2. Effect of reaction time at 50° C. on color development.**

5-30 μg. per ml. and the other for 10-60 μg. per ml. (Figure 3). The low range curve is based on the extraction of the colored reaction products in 10 ml. ether; 20 ml. ether were used for the high range.

It was also necessary to increase the volume of eluate collected from the anion column in order to insure maximum recovery of galacturonic acid. Recoveries of galacturonic acid added to orange juice were as low as 35% when 100 ml. of eluate were collected, but averaged 96% when the eluate volume was increased to 200 ml.

The carbazole-sulfuric acid-uronic acid reaction has also been advocated for the determination of free galacturonic acid. This method has the advantage of lower cost and greater stability of carbazole as compared to naphthoresorcinol. The procedures that have been published *(1, 2, 8)* were investigated and found not sufficiently sensitive in the concentration range of galacturonic acid indigenous to citrus.

## METHOD

**Reagents:**

Acetone, c.p.

Celite, analytical grade.

Activated carbon—Nuchar C-115-A was used in this work.

Ion exchange resins—Duolite C-3 cation resin and A-4 anion resin were used. The resins should be regenerated according to the manufacturer's instructions.

Hydrochloric acid, concentrated.

α-D-galacturonic acid monohydrate (Eastman No. 4607).

Naphthoresorcinol, Eastman No. P2080, 10 mg./ml. in acetone (1 part plus 3 parts water). The reagent should be prepared fresh each time.

Citric acid, anhydrous, c.p.
Ether, c.p.
Sodium sulfate, anhydrous, c.p.

**Preparation of standard curve.** Prepare a stock solution containing 0.25 mg. galacturonic acid, monohydrate per ml. Add a few drops of chloroform as a preservative; the solution is stable for 3-4 days if kept refrigerated. Weigh 250 mg. anhydrous citric acid into a 50 ml. volumetric flask, add the desired quantity of stock solution and make to volume with water. Dilutions should cover the range 5 to 60 μg./ml. and two curves prepared, one for 5-30 μg./ml. and the second for 10-60 μg./ml. Proceed as under *Determination of Galacturonic Acid.*

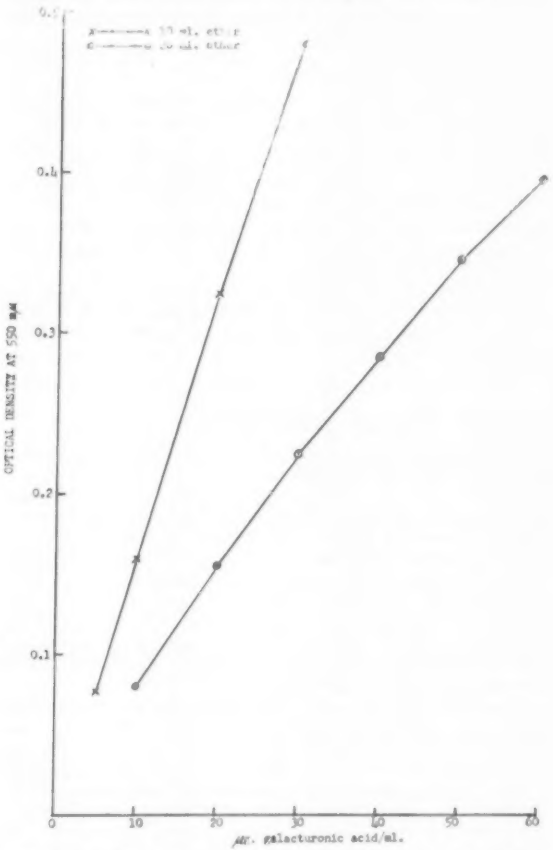


**Figure 3. Standard curves for galacturonic acid in citrus products.**

**Preparation of sample.** If the sample has not been previously subjected to heat treatment, it should be heated to 85° C. for one minute to inactivate pectic enzymes, then rapidly cooled.

Measure 125 ml. sample into a 250 ml. volumetric flask and add acetone gradually to the mark with constant mixing. Shake and allow to stand for 10 minutes. Again add acetone to volume. Shake and allow precipitate to settle. Filter through paper (E&D No. 195). The filtrate should be clear. Transfer 200 ml. filtrate to a 600 ml. beaker, add glass beads and evaporate to 100 ml. Decolorize solution at approximately 80° C. with 1 g. activated carbon (Nuchar C-115-A), cool and filter, using filter aid, on a Buchner funnel. Solution should be clear.

**Ion exchange treatment.** Pass the clarified, decolorized sample through the cation and anion columns at a flow rate of 7-8 ml. per minute. Follow with 250 ml. water. Each column should contain about 30 ml. (wet volume) of the appropriate resin.

Backwash the anion column with 300 ml. water. Elute the acids with 75 ml. of 1 + 9 HCl at a flow rate of 8-10 ml./min., followed by 125 ml. water. Discard the first 10 ml. of effluent; collect the balance in a 200 ml. flask and make to volume with water.

**Determination of galacturonic acid.** Pipette 1.0 ml. of the acid effluent into a 25 ml. glass stoppered cylinder. Add 2 ml. concentrated HCl followed by 2.0 ml. of naphthoresorcinol reagent. Shake and place in a water bath at 50° C. ± 1° C. for exactly 3.5 hours. Remove, cool to room temperature, and add either 10 or 20 ml. ether, depending on the galacturonic acid concentration. Stopper and shake for 5-7 minutes to dissolve the pigments. Allow to stand 4 minutes. Decant the ether layer into test tubes containing 0.5 g. anhydrous $Na_2SO_4$. Stopper, shake and allow to stand for 2 minutes. Transfer the clear ether extract to an absorption tube and determine optical density or percent transmission against a blank prepared by taking a 0.5% citric acid solution through the steps following *Ion Exchange Treatment.*[b] The determinations should be made at 550 mμ.

## RESULTS

Galacturonic acid determinations were made during the 1952 California Valencia and Washington Navel orange harvest. Included were representative samples of commercially processed and hand reamed juices (Table 1), pasteurized concentrates (Table 2), and whole fruit reduced to a slurry in a Waring blender (Table 3). All of the fruit examined was sound; hence

[b] A Bausch and Lomb monochromatic colorimeter was used in this study.

**TABLE 1**
**Free galacturonic acid in orange juice**

| Date | Variety | Method of extraction | Brix 20° C. | Percent acid w/w | Free galacturonic [c] acid mg./L. |
|---|---|---|---|---|---|
| 8-5-52 | Valencia | Machine reamed | 11.5 | 0.97 | 8.4 |
| 8-12-52 | Valencia | Machine reamed | 11.5 | 0.96 | 7.8 |
| 11-3-52 | Valencia | Machine reamed | 14.6 | 1.00 | 10.4 |
| 11-3-52 | Valencia | Machine reamed | 12.7 | 0.95 | 7.0 |
| 11-3-52 | Valencia | Hand reamed | 14.3 | 1.00 | 6.4 |
| 11-3-52 | Valencia | Hand reamed | 11.7 | 1.3 | 7.4 |
| 11-10-52 | Valencia | Hand reamed | 12.6 | 1.1 | 7.6 |
| 11-10-52 | Valencia | Hand reamed | 14.0 | 0.96 | 6.6 |
| 11-10-52 | Valencia | Machine reamed [d] | 12.0 | 1.22 | 5.7 |
| 11-10-52 | Valencia | Machine reamed [d] | 15.0 | 1.00 | 3.8 |
| 12-1-52 | Navel | Machine reamed | 12.2 | 1.4 | 9.0 |
| 12-1-52 | Navel | Machine reamed | 11.6 | 1.2 | 9.2 |

[c] As monohydrate.
[d] Depulped in centrifuge.

**TABLE 2**
**Free galacturonic acid in reconstituted Valencia orange juice**

| Date | Brix 20° C. | Percent acid w/w | Free galacturonic [e] acid mg./L. |
|---|---|---|---|
| 5-15-52 | 12.0 | 1.57 | 10.0 |
| 5-17-52 | 12.0 | 1.52 | 5.69 |
| 5-29-52 | 12.0 | 1.50 | 6.11 |
| 5-29-52 | 12.0 | 1.48 | 5.04 |
| 7-1-52 | 12.0 | 1.39 | 5.43 |
| 7-1-52 | 12.0 | 1.44 | 5.88 |
| 7-26-52 | 12.0 | 1.24 | 4.80 |
| 7-26-52 | 12.0 | 1.26 | 4.39 |
| 9-19-52 | 12.0 | 1.06 | 4.23 |
| 9-19-52 | 12.0 | 1.07 | 5.88 |
| 10-4-52 | 12.0 | 1.14 | 2.85 |
| 10-4-52 | 12.0 | 1.16 | 4.65 |

[e] As monohydrate.

**TABLE 3**
**Free galacturonic acid in whole fruit**

| Date | Variety | Free galacturonic acid[f] mg./100 g. wet substance |
|---|---|---|
| 8-5-52 | Valencia | 2.0 |
| 11-10-52 | Valencia | 2.1 |
| 12-1-52 | Navel | 2.0 |
| 11-18-52 | Lemon, soft [g] | 0 |
| 11-18-52 | Lemon, firm | 0 |

[f] As monohydrate.
[g] Over-mature, but not grossly decomposed.

the data do not include results on fruit affected by internal rot or other forms of decomposition by microbial means. The objective of the study was to determine the range of galacturonic acid in fruit of varying maturity, particularly at the time of physiologic breakdown that characterizes senescence.

## DISCUSSION

On the basis of results obtained during this study, it appears that the concentration of free galacturonic acid in California Valencia orange juice is not related to maturity, short of gross decomposition. The galacturonic acid content of navel juice seems to follow a similar pattern, although the data on navel juice are insufficient to warrant a conclusion. Galacturonic acid is either absent in the lemon fruit and juice, or present in such small quantities as to be undetectable by the method used. In view of these results, galacturonic acid concentration cannot be used as a practical means for determining maturity or internal condition of California citrus fruit.

## SUMMARY

A method for the determination of free galacturonic acid in citrus fruit, juices, and concentrates has been presented. Determinations of free galacturonic acid in California Valencia, Navel, and lemon fruit and juice have been made.

## LITERATURE CITED

1. Dietz, James H., and Rouse, A. H. A rapid method for estimating pectic substances in citrus juices. *Food Research*, **18**, 169-177 (1953).
2. Dische, Z. A new specific color reaction of hexuronic acids. *J. Biol. Chem.*, **167**, 189-198 (1947).
3. Harris, Thomas H. Report on decomposition in fruit products. *J. Assoc. Official Agr. Chemists*, **31**, 501 (1948).
4. Joslyn, M. A., Mist, S., and Lambert, E. The clarification of apple juice by fungal pectic enzyme preparations. *Food Technol.*, **6**, 133 (1952).
5. Kertesz, Z. I. *The Pectic Substances*. 1951, Interscience Publishers, Inc., New York.
6. Mills, Paul A. Report on galacturonic acid in strawberry juice. *J. Assoc. Official Agr. Chemists*, **34**, 513 (1951).
7. Mills, Paul A. Report on galacturonic acid in strawberry juice. *J. Assoc. Official Agr. Chemists*, **35**, 520 (1952).
8. Stark, S. M., Jr. Determination of pectic substances in cotton. *Analy. Chem.*, **22**, 1158-1160 (1950).
9. Winkler, W. O. Report on decomposition in fruits and fruit products. Galacturonic acid. *J. Assoc. Official Agr. Chemists*, **34**, 506 (1951).
10. Winkler, W. O. Report on decomposition in fruits and fruit products. A determination of galacturonic acid. *J. Assoc. Official Agr. Chemists*, **35**, 513 (1952).

# Preparation of Dehydrated Agar Media Containing Orange Juice Serum

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**A two-stage process for preparing dehydrated orange juice is presented. Low temperature evaporation is employed to remove a major part of the water and the resulting concentrate is mixed with other ingredients to obtain a moist, discontinuous mass. Moisture content is reduced to about 1 to 1.5% in a high vacuum shelf drier. The process yields a readily dispersible, dehydrated media and the rehydrated product is brilliantly clear.**

Much work has been done in the citrus products industry to find a satisfactory culture medium for enumeration of microorganisms in orange and other juice products. The problem has been difficult because of the large number of species and strains of bacteria, yeast, and molds found in juice. Many of these organisms are capable of growing in juice and causing off-flavor development and other undesirable changes. The need for a satisfactory medium for use in their control has become more acute with the advent of juice products which depend primarily on frozen storage for preservation.

Orange serum agar has had the widest acceptance of any medium so far proposed for use with citrus juice products. This medium appears to have been developed independently by Hays *(2)*, and by Troy and Beisel as reported by Murdock, Folinazzo, and Troy *(3)*. These investigators found this medium more satisfactory for the detection of spoilage organisms in citrus juices than tomato serum agar used in earlier work.

The formulas used by these workers in the preparation of orange serum agar are:

| | Hays | Troy and Beisel |
|---|---|---|
| Tryptone | 10 g. | 10 g. |
| Yeast extract | 3 g. | 3 g. |
| Dextrose | 4 g. | 5 g. |
| Potassium phosphate, dibasic | 2-3 g. | 2.5 g. |
| Agar | 17 g. | 20 g. |
| Orange serum | 200 ml. | 200 ml. |
| Water, distilled | 800 ml. | 800 ml. |

Hays adjusted the pH of his medium to about 5.5 by using different amounts of dibasic potassium phosphate. The method used in clarifying orange juice to obtain a clear serum was not described.

Murdock, Folinazzo, and Troy *(3)* in their studies on the relative values of different culture media, adjusted the pH of the medium to about 5.4. The method of preparing the orange serum was described as follows: "Heat 1000 ml. of freshly extracted orange juice to approximately 200° F. and add 30 g. of Filter-cel. Mix thoroughly. Filter through a Buchner funnel containing coarse filter paper and a layer of Filter-cel. Discard first few ml. of filtered serum. If serum is not used immediately, it may be sterilized 30 minutes in flowing

steam (212° F.) or stored unheated at 0 to —10° F. until ready for use."

This medium is extensively used in the citrus industry for determining total microorganism content of citrus juice products. It is effective in supporting the growth of organisms capable of causing spoilage in orange juice, particularly bacteria of the lactic acid group which tend to be somewhat exacting in their nutritive requirements.

Since orange serum agar was not available commercially at the time these studies were made,[a] it was necessary for the laboratories of the various citrus processing plants to prepare their own medium. Preparation is time consuming, particularly the operations required in clarifying the orange juice and adjusting the pH of the medium. Also, significant variations in different batches may occur due to differences in the composition of juice and other factors.

The need for a more convenient medium of uniform composition and productivity was generally recognized in the industry. A careful study of the various factors that cause variation resulted in the conclusion that a dehydrated product would best meet the industry-wide need for uniformity and convenience. This conclusion led to the studies to devise a method of producing dehydrated orange serum agar, as described herein.

## DRYING METHOD

The method of preparing dehydrated media containing orange serum was based on previous experience in the drying of citrus juices. The basic principle used is the same as that employed in the preparation of a dried orangeade product, as described by Pritchett, Stevens, and Baier *(4)*, also by Stevens, Pritchett, and Baier *(5)*.

The first step entails the enzymatic clarification of orange juice to obtain a brilliantly clear serum. The clear serum is then concentrated in a high vacuum, low temperature evaporator to remove a major proportion of the water. The desired amount of the concentrate is added to the other ingredients of the medium while they are being stirred mechanically and stirring is continued until the concentrate is spread uniformly over the other components to give a moist, discontinuous mass. The moisture content is then reduced to about 1 to 1.5% in a vacuum shelf drier. The details of each of these steps are given below.

**Preparation of orange serum.** An enzymatic method of clarifying juice, developed in this laboratory (Stevens and Pritchett), is used in preparing orange serum. The method produces a serum that remains clear under the conditions of use up to pH 6.8.

In this process complete flocculation of the insoluble solids of the juice is hastened by the addition of 0.035% pectinesterase No. 5, manufactured by Rohm and Haas, and 0.05% calcium carbonate. About 2 hours at 100° F. are required for complete precipitation of the soluble pectin in the juice, which causes the insoluble matter to flocculate and settle out, leaving a clear supernatant liquid or serum.

In these studies the flocculated juice was passed through a Sharples super centrifuge to remove the bulk of the insoluble matter. About 1% of good grade diatomaceous filter aid was added to the centrifuged juice and the mixture was then passed through a filter mat on a Buchner funnel, without the use of heat, to obtain a brilliantly clear serum. The filter mat was prepared by depositing a layer of paper pulp on a filter cloth in the funnel and then coating the paper pulp layer with filter aid, somewhat as described by Hall and Baier *(1)*.

The use of calcium carbonate in the clarification process, to promote flocculation of insoluble solids, reduces the titrable acidity of the juice, with a corresponding increase in pH, as may be seen by referring to Table 1.

**Concentration of orange serum.** The serum is concentrated in a vacuum evaporator to the desired degrees Brix, preferably in a low temperature evaporator at a temperature not exceeding about 70° F. If a concentrate of 80 to 87° Brix is needed the concentration can be carried as far as possible at the lower temperature and then finished at a higher temperature of about 80 to 105° F. to reduce the viscosity of the concentrate for easier handling.

The extent of concentration necessary depends upon the proportion of juice solids desired in the final dehydrated product. To obtain a juice solids content of about 41%, such as obtained with the original orange serum agar formulas with 12° Brix juice, the serum is concentrated to about 83 to 87° Brix. When dehydrated media of lower percent juice solids are desired, concentrates of correspondingly lower degrees Brix are used.

The curves in Figure 1 show the approximate range in degrees Brix that is satisfactory for use with each proportion of juice solids over the range of 15 to 45% in the dry medium. These curves are based on the use of dried agar in preparing the medium.

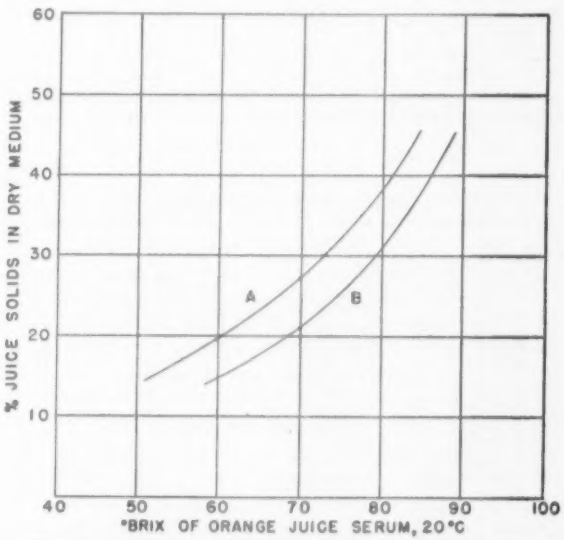


**Figure 1. Curves showing the approximate range in degrees Brix of orange serum that is satisfactory in obtaining any desired percent juice solids in the dry medium from 15 to 45 percent. Curve A—minimum degrees Brix, Curve B—maximum degrees Brix.**

**Mixing the concentrate with other ingredients.** The concentrate and the other ingredients of the medium may be mixed in preparation for drying by any method that will insure uniform spreading of the serum over the surfaces of the non-juice components. In this work all of the non-juice ingredients were first mixed together in the bowl of a laboratory model Read Mixonette. Serum concentrated to within the degrees Brix indicated in Figure 1 was then slowly added, in the amount preselected to provide the desired percentage of juice solids in the dehydrated medium, while stirring the mix. Stirring was continued until the concentrate was distributed uniformly over the other materials. Under the prescribed conditions the final mix will be uniformly moist but not wet or pasty enough to cause the individual lumps or pellets to adhere together to form a continuous mass.

**Drying of medium.** After thorough mixing, the moist medium is spread out in trays for drying, using 200 to 300 g. of

[a] It is understood that one of the commercial producers of culture media has experimented with and produced a dehydrated orange serum agar medium and that the product has been made available commercially very recently. No data are available concerning the method of manufacture, orange juice content, and other properties of this product.

medium per square foot of tray surface. The trays are placed in a vacuum shelf dryer, such as the Stokes lyophile apparatus, and dried, preferably at 2 mm. of pressure, or less. The heating water of the oven is set at 120° F. or lower, to conform to the preferred practice. The medium is reduced to a moisture content of about 1 to 1.5%. When properly mixed it will be found that the medium dries to this moisture content in about 4 to 8 hours.

The dried product is passed through an attrition mill, preferably in a dry atmosphere, to obtain about 20- to 40-mesh particle size for packaging.

## EXPERIMENTAL USE OF THE DRYING METHOD

Various samples of dehydrated orange serum agar media were prepared by the above method. Some of these were made to conform rather closely to the formulas of the original investigators. In others the amounts of juice solids, tryptone, phosphate, and sugar were changed from the original specification. In some cases the pH of the medium was adjusted before drying by changing the amount of dibasic potassium phosphate but in most cases the pH was adjusted at the time of use. Samples also were prepared which contained only orange serum, agar, and dibasic potassium phosphate. These variations in the composition of the medium were made primarily to determine their effects on drying characteristics, hygroscopicity, and stability.

The orange serum concentrates used in the preparation of these samples are shown in Table 1. The formulas used in the preparation and the final composition of representative samples of the experimental media are shown in Table 2.

The pH of each medium was taken after reconstitution with water, before and after sterilization. The data on pH and pH adjustment are shown in Table 3.

The final moisture content of each product, after grinding, was determined by drying for 15 to 16 hours in the Stokes lyophile apparatus, under 0.2 to 2.0 mm. pressure, with the shelf heating water set at 120° F. These results are shown in Table 2.

## RESULTS AND DISCUSSION

It is evident from the results of these studies that the orange serum agar medium devised by Hays *(2)* and by Troy and Beisel *(3)* can be successfully prepared in dehydrated form by the proposed method. By using an enzymatic method of preparing orange serum and by removing the major proportion of the water from the serum in a low temperature vacuum evaporator before mixing with the other ingredients for the final drying, it is possible to avoid the damaging effects of heat in the dehydration of the product. The dehydrated product has essentially the same productivity as the medium prepared with fresh serum. It redisperses readily in water and maintains its clarity under conditions of use up to pH 6.8. The product when properly protected from moisture is stable for more than one and a half years under ordinary room temperature storage conditions.

**TABLE 1**

**Data on concentrated orange juices used in the preparation of dehydrated orange serum agar media**

| Sample No. | Description | ° Brix 20° C. | Citric acid anhyd. % | pH | Solids/acid ratio |
|---|---|---|---|---|---|
| A-5133 | Navel orange juice (from Brown extractors) | 11.52 | 1.14 | 3.45 | 10.11 |
| A-5134 | Treated with pectinesterase and $CaCO_3$ and then clarified | 11.45 | 1.05 | 3.57 | 10.90 |
| A-5141 | Concentrate | 86.4 | 7.94 | 3.30 | 10.88 |
| A-5141-1 | Concentrate | 77.0 | 7.08 | ..... | 10.88 |
| A-5141-2 | Concentrate | 68.4 | 6.29 | ..... | 10.87 |
| A-5205 | Navel Orange Juice (Hand burred) | 14.91 | 0.89 | 3.90 | 16.75 |
| A-5206 | Treated with pectinesterase and $CaCO_3$ | 15.00 | 0.79 | 4.00 | 18.99 |
| A-5207 | Clarified | 15.00 | 0.79 | 4.00 | 18.99 |
| A-5207-1 | Acidified with citric acid | 15.20 | 0.98 | 3.84 | 15.51 |
| A-5208-1 | Concentrate | 82.7 | 5.29 | 3.66 | 15.63 |
| A-5208-2 | Concentrate | 81.5 | 5.22 | 3.65 | 15.61 |
| A-5208-3 | Concentrate | 70.0 | 4.48 | ..... | 15.63 |
| A-5208-4 | Concentrate | 60.0 | 3.84 | ..... | 15.63 |

**TABLE 2**

**Data on the preparation of dehydrated orange serum agar media**

| Sample No. | Concentrated orange juice serum used | Ingredients used, g./liter of final medium | | | | | | Theoretical total solids g./l. | Dried weight g./l. | Moisture content of dried product % | Juice solids content of dried product % | Natural strength juice equivalent of dried product [d] ml./l. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tryptone | Yeast extract (dehydrated) | Potassium phosphate, dibasic | Dextrose | Orange juice solids | Agar (dried) | | | | | |
| A-5148 | A-5141 | 10 | 3 | 2.5 | 6.5[b] | 24.2 | 15 | 61.2 | 59.5 | 1.52 | 40.7 | 193 |
| A-5149 | A-5141 | 5 | 3 | 2.5 | 11.5[c] | 24.2 | 15 | 61.2 | 60.2 | 1.45 | 40.2 | 193 |
| A-5210 | A-5208-1 | 10 | 3 | 2.5 | 5.0 | 23.8 | 15 | 59.3 | 58.6 | ..... | 40.6 | 190 |
| A-5210-6c | A-5208-2 | 10 | 3 | 2.5 | 5.0 | 23.8 | 15 | 59.3 | 57.7 | 2.75 | 41.2 | 190 |
| A-5219 | A-5208-2 | 3 | 3 | 2.0 | 8.4 | 13.4 | 14 | 43.8 | 42.3 | 2.22 | 31.7 | 107 |
| A-5220 | A-5208-2 | 10 | 3 | 2.5 | 5.0 | 23.8 | 15 | 59.3 | 57.7 | 1.79 | 41.2 | 190 |
| A-5221 | A-5141 | 10 | 3 | 2.5 | 5.0 | 24.0 | 15 | 59.5 | 58.4 | 1.89 | 41.1 | 191 |
| A-5222 | A-5208-1 | 3 | 3 | 2.0 | 6.53 | 19.0 | 14 | 47.6 | 46.8 | 1.25 | 40.6 | 151 |
| A-5225 | A-5208-2 | 10 | 3 | 2.5 | 4.68 | 21.6 | 15 | 56.8 | 55.9 | 1.06 | 38.6 | 172 |
| A-5234 | A-5208-2 | 10 | 3 | none | 6.06 | 19.7 | 15 | 53.8 | 52.9 | 0.97 | 37.2 | 157 |
| A-5515 | A-5208-3 | 10 | 3 | 0.7 | 5.0 | 12.6 | 15 | 46.3 | 45.7 | 1.10 | 27.6 | 100 |
| A-5516 | A-5208-4 | 10 | 3 | 0.1 | 5.0 | 8.2 | 15 | 41.3 | 40.9 | 1.16 | 20.0 | 65 |
| A-5517 | A-5208-2 | 10 | 3 | 2.15 | 5.0 | 23.9 | 15 | 59.0 | 58.7 | 1.35 | 40.7 | 190 |
| A-5518 | A-5208-2 | none | none | 1.0 | none | 8.1 | 15 | 24.1 | 23.7 | 0.98 | 34.2 | 65 |
| A-5525 | A-5141-1 | 10 | 3 | 1.2 | 5.0 | 12.8 | 15 | 47.0 | 45.9 | 1.02 | 27.9 | 102 |
| A-5526 | A-5141-2 | 10 | 3 | 0.4 | 5.0 | 8.4 | 15 | 41.8 | 40.9 | 1.03 | 20.5 | 67 |
| A-5527 | A-5141 | none | none | 1.98 | none | 11.5 | 15 | 28.5 | 27.7 | 1.01 | 41.5 | 92 |

[b] Includes 1.7 g. of sucrose.
[c] Includes 1.5 g. of sucrose.
[d] 12° Brix used as average for California orange juice.

**TABLE 3**

**Adjustment of pH of dehydrated orange serum agar media**

| Sample No. | Amount of dehydrated medium used g./l. | pH of unadjusted, unheated medium | Citric acid, or sodium hydroxide solution added | | pH before and after sterilization* | | Citric acid, anhydrous g./l. | |
|---|---|---|---|---|---|---|---|---|
| | | | Citric acid anhydrous g./l. | Sodium hydroxide solution, 0.993 N ml./l. | Before | After | Before pH adjustment | After pH adjustment |
| A-5148 | 59.5 | 5.08 | .... | 6.0 | 5.49 | 5.44 | 2.22 | 1.98 |
| A-5149 | 60.2 | 4.89 | .... | 8.0 | 5.45 | 5.40 | 2.22 | 1.90 |
| A-5210 | 58.6 | 5.84 | 0.2 | .... | 5.54 | 5.50 | 1.52 | 1.72 |
| A-5210-6c | 58.4 | 5.84 | 0.3 | .... | 5.46 | 5.40 | 1.52 | 1.82 |
| A-5219 | 42.9 | 6.10 | 0.3 | .... | 5.47 | 5.42 | 0.86 | 1.16 |
| A-5220 | 57.7 | 5.93 | 0.3 | .... | 5.47 | 5.44 | 1.53 | 1.83 |
| A-5220 | 57.7 | 5.87 | .... | .... | 5.87 | 5.74 | 1.53 | 1.53 |
| A-5220 | 57.7 | 5.87 | .... | 5.0 | 6.36 | 6.15 | 1.53 | 1.33 |
| A-5220 | 57.7 | 5.87 | .... | 11.0 | 6.83 | 6.54 | 1.53 | 1.09 |
| A-5220 | 57.7 | 5.87 | .... | 15.0 | 7.10 | 6.84 | 1.53 | 0.93 |
| A-5221 | 58.6 | 5.17 | .... | 4.0 | 5.45 | 5.39 | 2.20 | 2.04 |
| A-52 2 | 46.8 | 5.64 | 0.07 | .... | 5.44 | 5.37 | 1.22 | 1.29 |
| A-52 5 | 55.9 | 5.96 | 0.33 | .... | 5.54 | 5.47 | 1.39 | 1.72 |
| A-5234 | 52.9 | 4.88 | .... | 8.0 | 5.56 | 5.54 | 1.26 | 0.94 |
| A-5515 | 45.7 | 5.75 | .... | .... | 5.75 | 5.72 | 0.81 | .... |
| A-5516 | 40.9 | 5.83 | .... | .... | 5.83 | 5.79 | 0.52 | .... |
| A-5517 | 58.7 | 5.59 | .... | .... | 5.59 | 5.54 | 1.53 | .... |
| A-5518 | 23.7 | 5.74 | .... | .... | 5.74 | 5.57 | 0.52 | .... |
| A-5525 | 45.9 | 5.44 | .... | .... | 5.44 | 5.39 | 1.18 | .... |
| A-5526 | 40.9 | 5.49 | .... | .... | 5.49 | 5.46 | 0.77 | .... |
| A-5527 | 27.7 | 5.20 | .... | 2.1 | 5.77 | 5.63 | 1.06 | .... |

* 15 minutes at 248° F.

One of the most important factors in the dehydration of the medium by the proposed method is the adjustment of the degrees Brix of the concentrated serum in accordance with the percent juice solids in the final dry product. It is desirable to have just enough free or unbound water in the concentrate, and other ingredients, to insure uniform spreading of the concentrate over the surfaces of the non-juice solids. If excessive water is present the mix becomes sticky or pasty and tends to "case harden" in drying, causing the drying rate to decrease. The danger of damage to the agar and stability of the product during the drying process also is increased. The disadvantage of having too little water present at the time of mixing is that it is more dfficult to spread the concentrate uniformly over the other ingredients. This difficulty can be avoided to a considerable extent by slowing down the rate of continuous addition of the concentrate while stirring the mix.

Commercial agar may contain as much as 16% moisture and for this reason it is preferable, although not necessary, that it be dried before use in dehydrated media. The moisture carried in the other non-juice ingredients ordinarily can be ignored. The water carried in dextrose monohydrate does not effect mixing but its effect in drying can be avoided by using the anhydrous product.

The extent of concentration of the orange serum necessary to obtain satisfactory mixing with each variation in juice solids content in the mix of from 15 to 45% is shown in Figure 1. Curve A of this figure shows the approximate minimum degrees Brix concentrate that can be used without obtaining too much moisture for satisfactory mixing and drying characteristics. Curve B shows the approximate corresponding maximum degrees Brix that can be used without too much difficulty in obtaining uniform spreading of the serum on the other ingredients.

The drying characteristics and other properties of the medium seem to be better when the higher degrees Brix concentrates are used. For this reason it is preferable to have the degrees Brix somewhat high rather than low.

The viscosity of concentrated orange serum, especially at degrees Brix of about 80 and higher, decreases rapidly with increase in temperature. This can be used to some extent to increase or decrease the rate of spreading in mixing the serum and other ingredients.

The control of the pH of the medium is more difficult with California orange juice because of its relatively high acidity. The pH can be adjusted either by varying the amount of dibasic potassium phosphate, as was done by Hays *(2)*, or by controlling the titrable acidity of the orange serum. In the use of the medium with citrus juice products it is the usual practice to adjust the pH to fall within the range of about 5.4 to 5.6. The medium dries satisfactorily over the pH range of 4.9 to 6.1 used in this work.

The agar, tryptone, and yeast extract are the best drying aids in the medium. Agar is excellent in this respect. Crystalline ingredients such as dextrose are considerably less effective and consequently the drying characteristics are best when such ingredients constitute a small proportion of the non-juice solids.

The medium can be dried with the juice solids constituting up to 50% of the weight of the dried product. The ease of drying increases with decrease in the proportion of juice solids. About 40% juice solids in the dry product is considered as the maximum that is satisfactory for general use. This proportion of juice solids corresponds to the solids contained in about 186 ml. of 12° Brix serum per liter of medium.

Orange serum dries easily on agar alone, using dibasic potassium phosphate to control the pH, with juice solids contents up to 42% in the final dry product (see sample No. A-5527 in Table 3). This product will supply juice solids corresponding to that contained in 92 ml. of 12° Brix serum per l. of medium when enough

of the dried product is used to furnish 15 g. of agar per liter. Such a product may have value as a base for preparing special media, by adding other needed ingredients, where orange serum is needed. The product would also be of value in determining the usefulness of orange serum as an ingredient in media for any special use. The product is less hygroscopic than dehydrated orange serum agar medium of comparable juice solids content.

Dehydrated orange serum agar is quite hygroscopic, especially when it contains a large proportion of juice solids. The hygroscopicity is roughly proportional to the juice solids content, decreasing appreciably as the juice solids fraction decreases. The product becomes relatively more hygroscopic at any juice solids level as the proportion of crystalline materials in the non-juice fraction is increased. This was shown in the high dextrose samples Nos. A-5149, A-5219, and A-5222 of Table 2.

The most important factor affecting the stability of the medium is its moisture content. Caking is an indication of excessive moisture.

Experimental samples containing more than about 3% moisture usually showed caking within about 12 months, the rate and extent of caking being roughly proportional to the moisture content. The use of larger amounts of sugar in the medium, such as used in No. A-5219, Table 2, increases the tendency to cake. Samples prepared by the standard formula and containing about 1.4 to 1.9% moisture have been stored for 14 to 16 months at room temperature without signs of caking. It is preferable to keep the moisture content below about 1.5%.

In-package desiccants are now available commercially for use with moisture sensitive materials. These offer a means of controlling moisture in dehydrated media, especially during the period after the container has been opened and the product is being used.

Although it is evident from the results of these studies that dehydrated orange serum agar which reconstitutes to conform substantially to the original formula can be prepared successfully, the juice solids are rather high from the standpoints of hygroscopicity and stability. To obtain better properties with respect to ease of drying, hygroscopicity, and stability, it would be desirable to reduce the orange solids content considerably below the level obtained with the original formulas, provided this can be done without imparing productivity. A lower juice solids content, within the range of from 20 to 40%, would also make it easier to prepare orange serum concentrate and standardize the medium.

An important consideration in the standardization of the medium is the proportions of reducing sugar and sucrose carried in the final product. The presence of an adequate amount of sucrose for the detection of gum formers is very desirable in the use of the medium in bacteriological control work in citrus processing plants. Unless care is taken in the preparation of orange serum a large part of the sucrose may be lost by hydrolysis, due to exposure to heat and other factors.

Data on the composition of fresh California orange juice are shown in Table 4. These data show representative values, with a few exceptions, of the more important constituents that are contributed to the medium by orange serum.

**TABLE 4**

**Approximate composition of fresh California orange juice [f]**

| Constituent | Content per 100 g. |
|---|---|
| Protein (N x 6.25) | 0.9 g. |
| Amino acid N | 0.05 g. |
| Fat (ether extract) | 0.2 g. |
| Soluble solids (Degrees Brix, 20° C.) | 12 g. |
| Acid, total, as anhyd. citric | 1.1 g. |
| Malic acid | 0.15 g. |
| Sugar, total, as invert | 9.2 g. |
| Reducing sugar | 4.6 g. |
| Sucrose | 4.4 g. |
| Ash, total | 0.4 g. |
| Calcium | 15 mg. |
| Magnesium | 12 mg. |
| Potassium | 180 mg. |
| Sodium | 6 mg. |
| Iron | 0.3 mg. |
| Phosphorus | 20 mg. |
| Sulfur | 8 mg. |
| Chlorine | 6 mg. |
| Carotene | 0.1 mg. |
| Thiamine ($B_1$) | 0.08 mg. |
| Riboflavin ($B_2$) | 0.03 mg. |
| Niacin | 0.2 mg. |
| Pantothenic acid | 0.1 mg. |
| Pyridoxin | 0.08 mg. |
| Folic acid | 0.004 mg. |
| Biotin | 0.002 mg. |
| Inositol | 200 mg. |
| Choline | 13 mg. |
| Flavanones | 100 mg. |
| Ascorbic acid | 53 mg. |

[f] These data are based on analyses of juices from navel and Valencia oranges.

The method of preparing dehydrated media used in this work can be modified for use in preparing media from various other fruit and vegetable juices, extracts, and the like.

## SUMMARY

A two-stage process for preparing dehydrated orange serum agar media is described. The major part of the water is removed from the orange serum in a low temperature evaporator to obtain a concentrate of the desired degrees Brix for mixing with the other ingredients to obtain a moist, discontinuous mass. The moisture content of this mixture is reduced to about 1 to 1.5% in a high vacuum shelf drier.

Medium dehydrated by this method rehydrates readily and gives a brilliantly clear solution. The productivity of the product is equal to that of medium prepared directly from fresh orange serum.

### Acknowledgment

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## LITERATURE CITED

1. Hall, J. A., and Baier, W. E. Filtering fruit juices and plant extracts. *Ind. Eng. Chem.*, 6, 6 (1934).
2. Hays, Glen L. The isolation, cultivation and identification of organisms which have caused spoilage in frozen concentrated orange juice. *Proc. Florida State Hort. Soc.*, 1951.
3. Murdock, D. I., Folinazzo, J. F., and Troy, V. S. Evaluation of plating media for citrus concentrates. *Food Technol.*, 6, 181-185 (1952).
4. Pritchett, D. E., Stevens, J. W., and Baier, W. E. Dehydrated orangeade by a two-stage process. *Food Technol.*, 5, 179-181 (1951).
5. Stevens, J. W., Pritchett, D. E., and Baier, W. E. Drying fruit juices. U. S. Patent No. 2,567,038, September 4, 1951.

# The Relation of Nitrates in Foods to Tin Plate Container Corrosion*

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**The corrosive action toward tin of nitrates, such as are present in some food products, was investigated, and found to be greatly dependent upon the pH of the media. The common canning technique of water blanching caused considerable loss of nitrates in the products studied, whereas steam blanching caused little or no loss. The detinning rate of containers packed with green beans was found to be dependent upon nitrate content and pH, but there was reason to believe that a corrosion accelerator other than nitrates was also present.**

The nitrates commonly found in certain canned foods have been reported to greatly accelerate corrosion during storage in tinplate containers. Culpepper and Moon *(1)* concluded that the detinning properties of pumpkin and beets might be attributed to nitrates. However, a survey of products such as the leafy and seed vegetables which have been found to contain considerable amounts of nitrates *(4)* will not consistently associate nitrate content with rapid detinning such as has been observed in storage packs examined in this laboratory. The findings of Culpepper and Moon were based upon the examination of nitrate-containing citric acid solutions having the same total acidity as the related canned product. Since that time work in the field of corrosion has related corrosion rate to pH rather than to total acidity. The present investigation, therefore, was designed to collect information concerning the effect of pH, rather than total acidity, upon nitrate corrosion. The products selected for study were green beans, known to be a rapid detinner, and mustard and turnip greens, products which although high in nitrates were believed to show little, if any, detinning.

## EXPERIMENTAL

**Analytical techniques.** Canned samples were prepared by compositing the entire contents of from 3 to 6 cans and homogenizing in a Waring blender. The determination of pH was made by the usual glass electrode technique. Nitrates were determined by reaction with m-xylenol (2,4-dimethyl phenol) according to the procedure of the Association of Official Agricultural Chemists *(3)*. Tin was determined by the polarographic procedure of Godar and Alexander *(2)*.

**Procedures.** *Study of the corrosive effects of buffered nitrate-citrate solutions.* The corrosive effects of buffered nitrate-citrate solutions in causing the detinning of plain tinplate containers was studied as follows: Standardized potassium nitrate solutions containing 0.3% citric acid were brought to various pH levels by the addition of sodium hydroxide, then diluted to obtain the proper nitrate ion concentration. They were heated to 203° F., placed in 202 x 214 tinplate cans, at a fill of 135 ml. per can, and then closed. Accelerated corrosion was obtained by storage at 130° F. for a period of 15 days after which the cans were opened and the solutions analyzed. The data obtained are shown in Table 1, from which the graphical representation of Figure 1 was taken. For convenience in discussion we will define the nitrate content as the nitrate ion concentration expressed in p.p.m.

The extent of detinning evidently depends upon 2 factors; namely, the nitrate ion concentration and the pH. The amount of nitrate ion used in oxidizing tin varied according to the relationship illustrated in Figure 2, which indicates that the end products of the reduction of the nitrate ion were not the same in all cases. For this reason it was not possible to write a single equation representing the reaction mechanism.

TABLE 1
**Effect of 15 days' storage at 130° F. in tinplate containers upon nitrate and tin contents of citrate buffers**

| pH | Initial nitrate (p.p.m.) | Final nitrate (p.p.m.) | Nitrate lost (p.p.m.) | Final tin content (p.p.m.) |
|---|---|---|---|---|
| 3.0 | 0 | .... | .... | 31 |
| 4.0 | 0 | .... | .... | 31 |
| 4.7 | 0 | .... | .... | 32 |
| 5.0 | 0 | .... | .... | 38 |
| 5.3 | 0 | .... | .... | 38 |
| 6.0 | 0 | .... | .... | 35 |
| 3.0 | 400 | 200 | 200 | 1,260 |
| 4.0 | 400 | 245 | 155 | 510 |
| 4.4 | 400 | .... | .... | 304 |
| 4.7 | 400 | 320 | 80 | 205 |
| 5.2 | 400 | 356 | 44 | 112 |
| 5.4 | 400 | 390 | 10 | 80 |
| 4.3 | 800 | .... | .... | 1,180 |
| 4.6 | 800 | .... | .... | 720 |
| 5.0 | 800 | .... | .... | 290 |
| 5.2 | 800 | .... | .... | 205 |
| 5.4 | 800 | .... | .... | 155 |

*Effect of small pH changes.* The study of citrate buffers suggested that relatively small pH changes in nitrate-containing products packed in plain tinplate containers might result in considerable difference in the amount of detinning during storage. This concept was studied using green beans as the basic product in the following manner: The green beans used were typical of those customarily grown for canning in Arkansas and the surrounding regions. Commercial packing conditions were

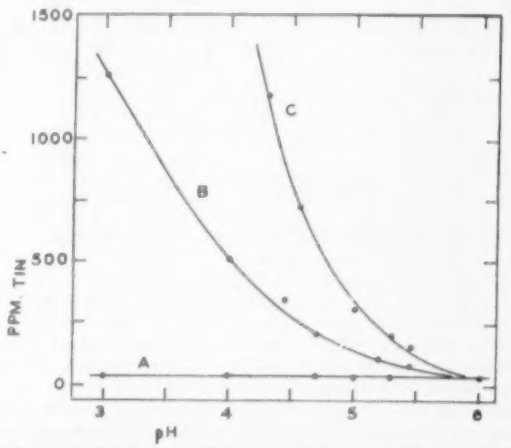


**Figure 1. Effect of pH on tin pickup at nitrate levels of (A) 0 p.p.m.; (B) 400 p.p.m.; (C) 800 p.p.m.**

* Presented at the Thirteenth Annual Meeting of the IFT, June 24, 1953, Boston, Massachusetts.

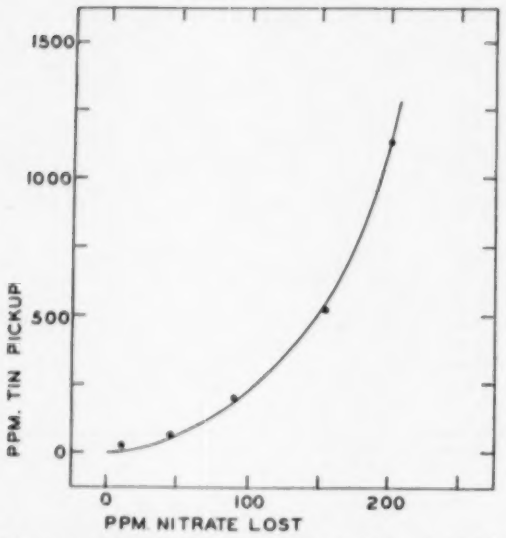


**Figure 2. Relationship of amount of nitrate ion used to amount of tin dissolved.**

followed wherever possible. Number 4 sieve extra standard cut green beans were water blanched for three minutes at 185° F., washed, and filled into 307 x 409 size cans. Measured amounts of citric acid-sodium nitrate solutions of predetermined concentrations were introduced into filled cans in such a manner as to place the additives as close to the bottom as possible. The cans were then filled with hot water (195°-200° F.), a 60 grain salt tablet added, closed, and the usual heat sterilization of 20 minutes processing time at 240° F. used. The initial analytical examination was performed one week after packing. The cans were then placed in storage at 98° F. for three months, and the final analysis made.

Table 2 shows the relative corrosivity of the various pH and nitrate levels used.

**TABLE 2**

**Effect of varying pH and nitrate levels upon the detinning of Arkansas green beans (three months storage at 98° F.)**

| Effect of nitrate level | | |
|---|---|---|
| Initial pH | Initial nitrate (p.p.m.) | Tin pickup (p.p.m.) |
| 5.40 | 225 | 260 |
| 5.45 | 508 | 410 |
| 5.25 | 679 | 510 |
| **Effect of pH level** | | |
| Initial pH | Initial nitrate (p.p.m.) | Tin pickup (p.p.m.) |
| 5.40 | 225 | 260 |
| 4.90 | 240 | 460 |
| 4.70 | 230 | 635 |

It is apparent that lowering the pH by 0.7 units caused a greater increase in tin pickup than that produced by a threefold increase in nitrate content from which it may be concluded that the relative effects noted previously in Table 1 may also be produced in green beans.

*Comparison of Arkansas with Wisconsin green beans.* The detinning rate of Arkansas green beans packed without the addition of nitrate or citric acid was compared with that of Wisconsin green beans having similar nitrate content and pH characteristics. Initial, 3, and 6 months' analyses for pH, tin, and nitrate are shown in Table 3.

It is apparent that the detinning observed in the Wisconsin beans was less than half that of those from Arkansas; moreover, the Wisconsin beans did not demonstrate any appreciable loss of nitrates. Since detinning occurred without nitrate loss, it might be inferred that a depolarizing or corrosion-accelerating substance other than nitrates was present. However, there is no apparent reason why detinning should not have proceeded to the same extent in both the packs.

*Study of mustard and turnip greens.* Deviations from expected behavior as predicted by the citrate buffer studies were also found to occur in mustard and turnip greens, products which show the same pH range and far higher nitrate contents

**TABLE 3**

**Comparison of Arkansas and Wisconsin green beans stored in tinplate containers at 98° F.**

| | pH | Nitrate content (p.p.m.) | Tin content (p.p.m.) |
|---|---|---|---|
| Arkansas green beans | | | |
| Initial | 5.40 | 225 | 14 |
| 3 months' storage | 5.18 | 47 | 260 |
| 6 months' storage | 5.09 | 46 | 492 |
| Wisconsin green beans | | | |
| Initial | 5.30 | 220 | 15 |
| 3 months' storage | 5.30 | 213 | 120 |
| 6 months' storage | 5.10 | 213 | 245 |

than green beans. On storing and examining these products, using procedures similar to those already described for green beans, resulting tin pickup (Table 4) was negligible in comparison to those previously noted. The interior tinplate surfaces of the cans packed with mustard or turnip greens invariably showed evidence of heavy sulfide staining, suggesting a possible mechanism inhibitory to nitrate detinning.

**TABLE 4**

**Examination of mustard and turnip greens stored in tinplate containers at 98° F.**

| | pH | Nitrate content (p.p.m.) | Tin content (p.p.m.) |
|---|---|---|---|
| Mustard greens | | | |
| Initial | 5.00 | 802 | 8 |
| 3 months' storage | 5.00 | 750 | 8 |
| 6 months' storage | 5.00 | 800 | 11 |
| Turnip greens | | | |
| Initial | 4.90 | 824 | 12 |
| 3 months' storage | 5.00 | 800 | 16 |
| 6 months' storage | 5.00 | 815 | 24 |

These storage experiments are exploratory in nature, and do not exemplify product performances as influenced by variety, growing conditions, variations in packing procedures, and storage conditions; such studies are beyond the scope of this discussion. Since the initial analyses reported here were made on the various products after processing, questions may arise concerning the effect of the usual canning procedures on the nitrate content of the materials used. Selecting blanching and heat sterilization as the steps in the usual canning technique most likely to alter the nitrate content of a vegetable, nitrates were determined before and after both water blanching and steam blanching (Table 5). As might be expected, water blanching resulted in losses in nitrate content of from 24.0 to 45.6%, whereas steam blanching produced little or no loss. The data in Table 6 show that typical processing schedules result in rather small nitrate losses.

**TABLE 5**

**Decrease in nitrate contents during blanching**

| Product | Type of blanch | Time (min.) | Temperature (° F.) | Nitrate content | | |
|---|---|---|---|---|---|---|
| | | | | Initial (p.p.m.) | Final (p.p.m.) | Percent decrease |
| Whole green beans | Water | 5.0 | 180 | 426 | 324 | 24.0 |
| Cut green beans | Water | 3.0 | 185 | 280 | 216 | 22.8 |
| Cut green beans | Water | 5.0 | 190 | 306 | 218 | 28.7 |
| Cut green beans | Steam | 1.5 | 212 | 280 | 272 | 2.9 |
| Mustard greens | Water | 4.0 | 190 | 1125 | 760 | 32.4 |
| Mustard greens | Water | 4.0 | 190 | 1775 | 973 | 45.2 |
| Turnip greens | Water | 4.0 | 190 | 1905 | 1172 | 38.5 |
| Turnip greens | Water | 4.0 | 190 | 1350 | 734 | 45.6 |
| Turnip greens | Steam | 0.5 | 212 | 1948 | 1948 | 0.0 |

TABLE 6

Effect of processing upon nitrate content

| Product | Processing conditions | | Nitrate content | | |
|---|---|---|---|---|---|
| | Time (min.) | Temperature (° F.) | Initial (p.p.m.) | Final (p.p.m.) | Percent loss |
| Cut green beans | 20 | 240 | 225 | 220 | 2.2 |
| Cut green beans | 20 | 240 | 97 | 97 | 0.0 |
| Turnip greens | 45 | 250 | 830 | 824 | 0.7 |
| Mustard greens | 45 | 250 | 826 | 802 | 2.9 |

## DISCUSSION

By the study of the detinning properties of nitrate-citrate buffer solutions, it has been demonstrated that the corrosivity of nitrate solutions is governed chiefly by their pH levels. This concept was in one instance reproduced experimentally in canned green beans; also, as expected, increase in corrosivity with increased nitrate content was found to occur. From this it is concluded that nitrates may be considered a potential detinning constituent in acid food products at pH levels as high as 5.4. However, nitrate corrosion may be almost completely inhibited by a mechanism which probably involves the formation of a protective film on the exposed tinplate surface, and such an inhibitory process is very likely also sensitive to pH changes. In green beans the corrosion process may be even more complex. Apparently, nitrate corrosion may be inhibited in the presence of detinning caused by another depolarizing agent.

## SUMMARY

The potential corrosivity of nitrate-containing vegetables toward tinplate containers is influenced greatly by what might appear to be relatively small changes in pH. Such changes could conceivably result from abnormal growing conditions, or the combination of a leafy vegetable high in nitrate content with a low pH product such as tomatoes. A change in canning technique such as the substitution of steam blanching for water blanching could also affect the detinning rate of a product during storage. However, the experimental evidence presented demonstrates that, at least in materials falling in the pH range of from 5.0 to 5.4, it is not possible to predict accurately the detinning properties of a vegetable product from a knowledge of its nitrate content.

## LITERATURE CITED

1. Culpepper, C. W., and Moon, H. H. The effect of nitrates upon the corrosion in tin cans. *Canning Age*, **9**, 619 (1928).
2. Godar, Edith M., and Alexander, O. R. Polarographic determination of tin in foods and biological materials. *Industrial and Engineering Chemistry, Analytical Edition*, **18**, 681 (1946).
3. *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists*, 6th Edition, 1945, p. 424. Association of Official Agricultural Chemists, Washington, D. C.
4. Wilson, J. K. Nitrates in plants: Its relation to fertilizer injury, changes during silage making, and indirect toxicity to animals. *J. Am. Soc. Agron.*, **35**, 279-290 (1943).

# The Effect of Chemical Defoliation on the Quality of Canned Tomatoes[a]

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(Manuscript received July 17, 1953)

**Chemical defoliation has been suggested as a possible means of increasing the rate of ripening of tomatoes grown in localities with a short growing season. This practice lowers the quality of the canned product as judged by color, ascorbic acid content and percent drained solids of the canned product. There is the possibility that the defoliation treatment may cause off-flavors.**

Chemical defoliation has been suggested as a possible means of increasing the rate of ripening of cannery tomatoes grown in the "fringe" areas. This is contrary, of course, to good cultural practice as modern spray programs are designed to keep the leaves on the plants in order to increase the yield and develop better color. However, in some areas, late season defoliation may be beneficial. This work was carried on to determine the effect of the defoliation process on the quality of the canned tomatoes.

## MATERIALS AND METHODS

Rutgers variety tomatoes were grown from seed and transplanted at Guelph in 1950. John Baer variety tomatoes were grown at Niagara in 1950 and Guelph in 1951. The plants were grown in a split plot design with 66 plants per plot. Finely ground calcium cyanamid as a defoliant dust was applied at the rate of 75 pounds per acre. The dates of defoliation and picking are indicated in Table 1.

The ascorbic acid analyses were performed using the indophenol titration method according to the official method of the Association of Official Agricultural Chemists.

The percent drained solids analyses were performed according to the specifications of the Meat and Canned Foods Act of the Canadian Department of Agriculture. The figures for total solids content were obtained with a Brabender Semi-Automatic Moisture Tester. A Coleman pH Electrometer was used for the pH measurements.

The tomato pigments were obtained in hexane solution by the method of Zscheile and Porter *(5)*. The xanthophylls were separated by the method described by Strain *(4)*, and the lycopene and carotene were chromatographed on a 1:1 mixture of MgO (Westvaco No. 2642) and filter aid. The carotenes were washed through the column with 1:1 acetone-hexane solution. The lycopene was eluted from the absorbent by blending with chloroform for 15 seconds in a Waring blender. Both pigments were estimated photometrically with a Klett-Summerson Photoelectric Colorimeter. The instrument was calibrated with beta-carotene, purified as described in the A. O. A. C. *Official Methods of Analysis*, and lycopene prepared as suggested by Davis *(1)*.

[a] Aided by a grant from the North American Cyanamid Company.

**TABLE 1**

**Analytical values for canned tomatoes from defoliated and control plots**

| Locality and year | Defoliation date | Picking date | Ascorbic acid content mg./100 g. | | Percent drained solids | | Percent total solids | | pH | | Color score $\tan^{-1}$ a/b | | Lycopene μg. per g. | | Carotene μg. per g. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Def. | Cont. | Def. | Cont. | Def. | Cont. | Def. | Cont. | Def. | Cont. | Def. | Cont. | Def. | Cont. |
| Guelph 1950 | Aug. 26 | Sept. 7 | 14.8 | 18.8* | 74.1 | 77.4 | 6.2 | 5.8 | 4.57 | 4.58 | 56.0 | 61.6 | 54.4 | 56.4 | 4.8 | 4.3 |
| | | | (4)[b] | (4) | (4) | (4) | (3) | (3) | (3) | (3) | (3) | (3) | (1) | (1) | (1) | (1) |
| | Aug. 26 | Sept. 19 | 14.4 | 16.3 | 70.3 | 70.4 | 5.7 | 5.9 | 4.46 | 4.48 | 56.0 | 58.4 | 57.4 | 63.8 | 6.0 | 6.1 |
| | | | (4) | (4) | (4) | (4) | (3) | (3) | (3) | (3) | (3) | (3) | (1) | (1) | (1) | (1) |
| | Sept. 5 | Sept. 19 | 14.9 | 16.9 | 68.6 | 73.5 | 5.8 | 5.9 | 4.54 | 4.57 | 54.2 | 57.4 | | | | |
| | | | (4) | (4) | (4) | (4) | (3) | (3) | (3) | (3) | (3) | (3) | | | | |
| Ave. | | | 14.7 | 17.3* | 71.0 | 73.8 | 5.9 | 5.9 | 4.52 | 4.54 | 55.4 | 59.1* | 55.9 | 60.1 | 5.4 | 5.2 |
| Niagara 1950 | Sept. 1 | Sept. 8 | 14.0 | 15.1 | 65.9 | 62.2 | 6.2 | 5.7 | 4.47 | 4.42 | 59.0 | 61.2 | 53.2 | 58.0 | 4.6 | 5.0 |
| | | | (4) | (4) | (4) | (4) | (3) | (3) | (3) | (3) | (3) | (3) | (1) | (1) | (1) | (1) |
| | Sept. 1 | Sept. 18 | 12.1 | 14.4* | 60.6 | 66.6 | 6.3 | 6.2 | 4.46 | 4.44 | 58.2 | 58.5 | 50.9 | 52.8 | 6.4 | 5.3 |
| | | | (4) | (4) | (4) | (4) | (3) | (3) | (3) | (3) | (3) | (3) | (1) | (1) | (1) | (1) |
| | Sept. 1 | Sept. 27 | 11.1 | 13.0* | 56.7 | 61.2* | 5.8 | 6.2 | 4.42 | 4.49 | 56.2 | 55.4 | 50.2 | 47.5 | 5.1 | 5.3 |
| | | | (4) | (4) | (4) | (4) | (3) | (3) | (3) | (3) | (3) | (3) | (1) | (1) | (1) | (1) |
| Ave. | | | 12.4 | 14.8* | 61.1 | 63.3* | 6.1 | 6.0 | 4.45 | 4.45 | 57.8 | 58.4 | 51.4 | 52.8 | 5.4 | 5.2 |
| Guelph 1951 | Aug. 26 | Sept. 15 | 17.3 | 19.8* | 68.8 | 72.0 | 6.1 | 6.2 | 4.56 | 4.60 | 55.1 | 53.4 | 46.3 | 51.9 | 5.0 | 5.7 |
| | | | (4) | (4) | (6) | (6) | (3) | (3) | (3) | (3) | (3) | (3) | (4) | (4) | (4) | (4) |
| | Sept. 2 | Sept. 15 | 18.4 | 19.0 | 72.0 | 74.1 | 6.1 | 6.2 | 4.49 | 4.46 | 52.0 | 51.5 | 58.2 | 54.2 | 5.5 | 5.5 |
| | | | (4) | (4) | (6) | (6) | (3) | (3) | (3) | (3) | (3) | (3) | (4) | (4) | (4) | (4) |
| | Aug. 26 | Sept. 23 | 12.9 | 18.0* | 68.0 | 72.8 | 6.0 | 6.3 | 4.42 | 4.50 | 54.3 | 55.9 | 55.6 | 53.7 | | |
| | | | (4) | (4) | (6) | (6) | (3) | (3) | (3) | (3) | (3) | (3) | (4) | (4) | | |
| | Sept. 2 | Sept. 23 | 18.2 | 18.9 | 72.8 | 73.4 | 6.0 | 6.2 | 4.55 | 4.48 | 56.3 | 58.9 | 53.1 | 54.3 | 5.5 | 5.2 |
| | | | (4) | (4) | (6) | (6) | (3) | (2) | (3) | (3) | (3) | (3) | (4) | (4) | (4) | (4) |
| Ave. | | | 16.7 | 18.9* | 70.4 | 73.1* | 6.0 | 6.2 | 4.51 | 4.51 | 54.4 | 54.9 | 53.3 | 53.5 | 5.3 | 5.5 |
| Overall average | | | 14.6 | 17.0* | 68.2 | 70.8* | 6.0 | 6.1 | 4.49 | 4.50 | 55.7 | 57.2* | 53.3 | 54.0 | 5.4 | 5.4 |

* Significant difference at the 0.05 level.

[b] The figure in brackets underneath the value represents the number of determinations.

The color of the canned tomatoes was obtained by removing the seeds with a colander and measuring the juice with a Hunter Color and Color Difference Meter. Circular glass cells with optical glass bottoms were employed with an ebonite plate having a 5.5 cm. circular opening. Hunter L, $a_L$ and $b_L$ readings were taken with small-area illumination. The instrument was standardized against a calibrated tomato-red tile. The a and b readings were converted to one score by calculating $\tan^{-1}$ a/b *(2)*. With this score, the higher values represent the redder tomatoes.

Each lot of canned tomatoes was tested for flavor by a panel of 10 judges using the triangular method described by Harrison and Elder *(3)*.

## RESULTS AND DISCUSSION

The results of the analyses are shown in Table 1. Perhaps the most important result is that the ascorbic acid values are lower in the defoliated fruit. It is well known that the ascorbic acid content varies with the exposure of sunlight but apparently when photosynthetic activity is cut off by removing the leaves, the ascorbic acid content of the fruit is lowered.

The color scores in 1950 showed that the control fruits were redder than the defoliated samples. In 1951, there was no significant difference, but this may be because the mean temperatures just after defoliation were considerably higher than in 1950. This resulted in a large percentage of sunscalded fruit which was discarded. If this fruit had been trimmed and canned, the color scores would probably be different.

The percent drained solids in the control fruit is consistently higher than in the defoliated samples, despite the fact that the total solids shows no significant difference.

Each lot of tomatoes was tested to see if the panel could detect a change in flavor due to the defoliation chemical. The results were negative except with one lot in 1951, which was defoliated on August 26 and picked September 23. Each can of this lot showed a sharp bitter flavor.

The values for pH, lycopene and beta-carotene showed no significant differences at the 0.05% level between the defoliated and the control samples. The average lycopene values are consistently higher in the control samples and this is shown in the color scores as well, as the lycopene content and the color score show a high correlation ($r = +0.865$ for 22 comparisons).

The defoliation treatment does lower the quality of the canned tomatoes and in view of this as well as the possibility of off-flavor development, it is hardly to be recommended under ordinary conditions.

## SUMMARY

Tomatoes from plots defoliated with calcium cyanamide were canned and compared with samples from the control plots. The control samples were redder and had a higher content of ascorbic acid, lycopene, and percent drained solids. No significant differences were found in pH and beta-carotene content. One lot of the defoliated samples had a sharp bitter flavor.

## LITERATURE CITED

1. Davis, W. B. Preparation of lycopene from tomato paste for use as a spectrophotometric standard. *Ind. Eng. Chem., Anal. Ed.*, **21**, 1226-28 (1949).
2. Francis, F. J. A method of measuring the skin color of apples. *Proc. Amer. Soc. Hort. Sci.*, **60**, 213-20 (1952).
3. Harrison, S., and Elder, L. W. Some applications of statistics to laboratory taste testing. *Food Technol.*, **4**, 434-9 (1950).
4. Strain, H. H. Chromatographic Absorption Analysis. Vol. II, 1945, Interscience Publ. Inc., New York.
5. Zscheile, F. P., and Porter, J. W. Analytical methods for carotenes of lycopersicon species and strains. *Ind. Eng. Chem., Anal. Ed.*, **19**, 47-51 (1947).

# Factors Influencing Tenderness of Principal Muscles Composing the Poultry Carcass[a]

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(Manuscript received July 6, 1953)

**The tenderness pattern of several muscles composing the poultry carcass was studied during the early post-mortem period. The factors that may interfere with tenderness were investigated. It is shown, under the conditions of this experiment, that freezing interferes with tenderness in that complete tenderization is delayed until the tissues are defrosted. The effect of immersion in hot water for different periods and the relationship to tenderness of such treatment are discussed.**

Factors influencing tenderness of muscles composing the poultry carcass may be placed in two categories. One category relates to tenderness that results from the action of enzymes on tissues. The second pertains to those factors that influence tenderness during the early post-mortem period and may be associated with rigor. This investigation is concerned only with tenderness as influenced by the latter group of factors.

Behavior of various muscles during early post-mortem has been studied by several investigators. It was pointed out in 1941 by Stewart, Lowe, and Morr *(7)* that rigor is a condition of the muscles characteristic of an early post-mortem state in most animals. During this period, the muscles are turgid and stiff. These investigators repoorted that rigor sets in during cooking when birds are held less than 4 hours after dressing and often remains after cooking. Cooked poultry flesh during rigor is extremely rubbery and tough. Tenderness in poultry meat increases rapidly with the passing of rigor. In 1942, Hansen, Stewart, and Lowe *(1)* observed histological changes in 2 breast muscles and 3 thigh muscles of chickens. They reported that muscle fibers showed characteristic nodes and internodes during rigor. The duration of time after the birds were dressed before these nodes and internodes appeared and disappeared varied considerably for the different muscles.

In 1944, Paul, Lowe, and McClurg *(4)* working with a number of beef muscles reviewed histological changes that took place during the period of rigor. Stewart *et al. (6)* described in 1945 histological changes in muscle tissue in broilers during the post-mortem period and also the effects of aging, freezing rate, and storage period on palatability. In 1946, Koonz and Robinson *(2)* described chemical and histological changes occurring in the more important chicken muscles at various time intervals after slaughter. It was observed that the muscles varied greatly with respect to their normal histology and that in most cases they exhibited changes in tenderness during the period of rigor. Belle Lowe *(3)* reviewed in 1948 factors influencing tenderness of poultry and indicated that the age of carcass after dressing and age of bird to be of principal importance. Also cutting muscles soon after slaughter and the fat in the carcass may affect tenderness. It was further reported that roasters frozen within two hours after dressing were less tender than birds aged for one day before freezing.

In the present study, the tenderness pattern during the early post-mortem period was determined for a number of the most important poultry muscles. In establishing a pattern, it was observed that irregularities were sometimes encountered and this prompted investigations to determine the factors that may interfere with the tenderness pattern observed for the several muscles.

## EXPERIMENTAL PROCEDURES AND RESULTS

In working out the tenderness pattern, muscles studied included the *biceps femoris, semitendinosus, semimembranosus, gluteus, adductor, quadriceps femoris, gastrocnemius, peroneus longus, pectoralis superficialis, pectoralis profundus, biceps brachii,* and *triceps brachii.* The relative sizes of these muscles, their shape, and their general characteristics may be observed in Figure 1. These 12 muscles include an important part of the meat on the poultry carcass.

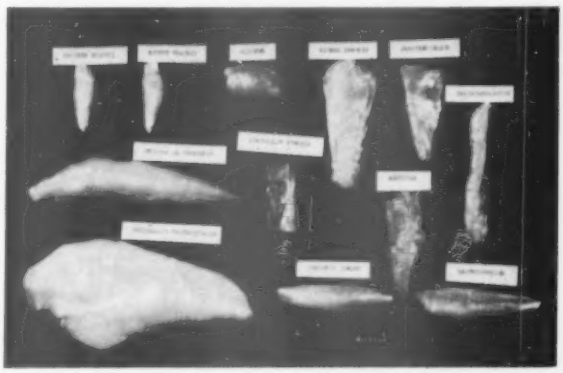

**Figure 1. Gross characteristics of the various muscles studied.**

Muscles from one side of the bird were used in securing shear values of raw tissues; those from the other side were used in securing similar values for cooked tissues. The shear readings were made at 0, 1, 2, 3, 4, 5, 6, 8, 10, 12, 16, 24, and 48 hours after poultry was dressed. The birds or their muscles were held at 4.4° C. (40° F.) in this and other experiments under conditions preventing dehydration. At each time interval, 3 broilers were used in obtaining an average shear value. Each muscle was sheared once across the grain at a point near its center. Tenderness readings for both the uncooked and cooked muscles were obtained with the Warner-Bratzler shear apparatus *(8).*

Muscles were cooked by heating in oil at 107.2° C. (225° F.). Each muscle was heated until an internal temperature of 85° C. (185° F.) was obtained. The time required for each muscle

[a] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 22, 1953.

**TABLE 1**

**Tenderness values of uncooked muscles at different time intervals after dressing**

| Muscle | Pounds required to shear muscles (Av. 3 birds) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 hrs. | 1 hr. | 2 hrs. | 3 hrs. | 4 hrs. | 5 hrs. | 6 hrs. | 8 hrs. | 10 hrs. | 12 hrs. | 16 hrs. | 24 hrs. | 48 hrs. |
| *Biceps femoris* | 18.0 | 16.0 | 13.3 | 12.3 | 12.0 | 16.0 | 16.3 | 13.7 | 10.3 | 15.3 | 9.7 | 12.3 | 11.7 |
| *Semitendinosus* | 7.0 | 6.7 | 6.0 | 5.7 | 6.0 | 5.0 | 5.7 | 6.7 | 4.7 | 4.3 | 3.3 | 5.3 | 4.7 |
| *Semimembranosus* | 9.0 | 7.7 | 8.0 | 9.0 | 8.3 | 6.0 | 8.0 | 10.0 | 5.3 | 7.3 | 5.7 | 6.3 | 5.7 |
| *Gluteus* | 9.7 | 20.3 | 21.0 | 14.0 | 15.0 | 18.0 | 9.0 | 20.7 | 8.3 | 16.0 | 9.3 | 14.3 | 11.7 |
| *Adductor* | 4.3 | 4.7 | 5.3 | 4.0 | 5.3 | 3.7 | 5.7 | 5.3 | 4.0 | 5.7 | 4.7 | 4.3 | 4.7 |
| *Quadriceps femoris* | 14.0 | 13.7 | 16.0 | 13.7 | 14.7 | 11.3 | 10.7 | 11.0 | 11.7 | 9.0 | 13.0 | 11.3 | 13.3 |
| *Gastrocnemius* | 16.7 | 20.3 | 22.7 | 15.3 | 18.3 | 17.3 | 16.0 | 21.7 | 12.0 | 17.3 | 14.0 | 17.0 | 13.3 |
| *Peroneus longus* | 17.0 | 15.0 | 18.0 | 18.0 | 15.0 | 18.7 | 14.3 | 27.0 | 15.7 | 16.7 | 12.0 | 12.7 | 18.0 |
| *Pectoralis superficialis* | 20.7 | 15.7 | 18.3 | 15.3 | 15.3 | 16.3 | 15.3 | 13.7 | 14.0 | 13.3 | 14.3 | 12.3 | 9.7 |
| *Pectoralis profundus* | 4.0 | 5.3 | 4.0 | 4.7 | 2.7 | 3.3 | 1.7 | 1.3 | 1.3 | 2.3 | 1.3 | 1.7 | 1.7 |
| *Biceps brachii* | 14.0 | 12.3 | 16.0 | 10.3 | 13.3 | 15.3 | 13.7 | 16.3 | 10.0 | 10.7 | 9.3 | 8.3 | 8.3 |
| *Triceps brachii* | 19.7 | 17.0 | 24.3 | 15.0 | 14.3 | 22.0 | 19.7 | 21.0 | 13.7 | 25.7 | 12.3 | 13.0 | 14.7 |

**TABLE 2**

**Tenderness values of cooked muscles at different time intervals after dressing**

| Muscle | Pounds required to shear muscles (Av. 3 birds) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 hrs. | 1 hr. | 2 hrs. | 3 hrs. | 4 hrs. | 5 hrs. | 6 hrs. | 8 hrs. | 10 hrs. | 12 hrs. | 16 hrs. | 24 hrs. | 48 hrs. |
| *Biceps femoris* | 8.7 | 6.3 | 10.0 | 7.7 | 7.7 | 6.7 | 4.3 | 8.3 | 6.3 | 4.7 | 5.3 | 5.0 | 3.0 |
| *Semitendinosus* | 7.7 | 5.0 | 7.3 | 5.0 | 5.7 | 3.3 | 2.3 | 4.7 | 3.0 | 2.7 | 3.7 | 4.7 | 2.7 |
| *Semimembranosus* | 6.0 | 4.0 | 8.3 | 6.0 | 5.7 | 4.0 | 3.7 | 6.0 | 3.7 | 4.7 | 3.0 | 3.3 | 1.7 |
| *Gluteus* | 4.0 | 4.7 | 7.7 | 5.7 | 5.0 | 5.7 | 4.3 | 7.3 | 4.0 | 5.7 | 5.3 | 5.7 | 4.0 |
| *Adductor* | 1.3 | 4.0 | 6.3 | 6.0 | 5.7 | 4.7 | 6.3 | 6.7 | 3.7 | 5.0 | 5.3 | 4.7 | 3.0 |
| *Quadriceps femoris* | 4.3 | 6.0 | 9.3 | 9.3 | 7.0 | 7.0 | 5.7 | 7.3 | 5.7 | 5.0 | 8.0 | 6.7 | 3.7 |
| *Gastrocnemius* | 3.3 | 4.0 | 5.7 | 3.0 | 4.0 | 3.7 | 2.0 | 5.3 | 3.3 | 5.0 | 3.0 | 3.3 | 2.0 |
| *Peroneus longus* | 2.0 | 2.7 | 5.0 | 3.3 | 3.3 | 2.7 | 1.7 | 3.0 | 2.0 | 2.7 | 2.7 | 2.7 | 1.7 |
| *Pectoralis superficialis* | 12.7 | 13.7 | 28.7 | 18.0 | 13.7 | 16.0 | 9.7 | 8.0 | 6.7 | 6.0 | 5.3 | 6.0 | 5.0 |
| *Pectoralis profundus* | 12.3 | 10.0 | 5.7 | 5.3 | 5.0 | 8.3 | 4.7 | 4.7 | 2.7 | 2.0 | 2.3 | 2.3 | 2.7 |
| *Biceps brachii* | 2.7 | 5.7 | 4.7 | 3.3 | 2.3 | 2.3 | 2.0 | 2.3 | 3.0 | 1.0 | 1.0 | 2.0 | 2.0 |
| *Triceps brachii* | 5.3 | 5.7 | 8.0 | 5.3 | 5.0 | 6.0 | 3.7 | 3.7 | 2.3 | 3.3 | 4.7 | 4.3 | 2.3 |

to reach the correct internal temperature was determined initially by the use of thermocouples; the time varied for each muscle since they were dissimilar in size and shape. The average tenderness values for the uncooked and cooked muscles at the various time intervals will be found summarized in Tables 1 and 2, respectively.

The results indicate that the muscles appeared, in general, to be less tender during the first few hours after the birds were dressed. This may be noted by observing the behavior of the *pectoralis superficialis* muscle. Generally, the muscles became relatively tender within 24 hours and some of them reached this state in a considerably shorter period of time.

It is of interest that the muscles generally became more tender after being cooked. Ramsbottom, Strandine, and Koonz *(5)* reported in 1945 that many beef muscles became less tender under similar conditions of cooking.

Tenderness of the several muscles was also determined organoleptically at 0, 1, 1½, 2, 3, 4, 5, 6, 8, 10, 12, 16, 24, and 48 hours after poultry was dressed. At each of the time intervals muscles from one side of each of the 3 birds were cooked and scored. Each muscle was scored by 3 individuals, 10 being the score for the most tender muscle and 1 being the score for the least tender muscle. Results of this experiment will be found summarized in Table 3.

There was a very close correlation between the shear value of uncooked and cooked muscles and the organoleptic evaluation of tenderness. This will become particularly apparent when observing the shear values and the organoleptic tenderness scores for the large breast muscle, the *pectoralis superficialis* (Figure 2).

Since tenderness values were obtained for excised muscles cooked in hot oil, it was felt that a check should be made to determine whether comparable results could be obtained in birds roasted prior to removing the umscles for scoring. Five roasters were cooked at 0, 2, 4, 16, and 24 hours after being dressed. The *biceps femoris, semitendinosus, gluteus, pectoralis superficialis, pectoralis profundus* muscles were then excised and their shear tenderness values determined. The results will be found summarized in Table 4. It will be noted that the results are very similar to those obtained when muscles are cooked in oil. The muscles were comparatively tough during the first few hours after birds were dressed but became relatively tender within 24 hours or less after dressing.

It becomes apparent that each muscle has a rather characteristic tenderness pattern during the early post-mortem period. It was felt that it would be expedient to make an investigation to determine whether the characteristic tenderness pattern could be altered experimentally.

**TABLE 3**

**Tenderness values determined organoleptically of cooked muscles at different time intervals after dressing**

| Muscle | Organoleptic values of cooked muscles (av. 3 birds) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 hrs. | 1 hr. | 1½ hrs. | 2 hrs. | 3 hrs. | 4 hrs. | 5 hrs. | 6 hrs. | 8 hrs. | 10 hrs. | 12 hrs. | 16 hrs. | 24 hrs. | 48 hrs. |
| *Biceps femoris* | 7.2 | 7.2 | 6.1 | 5.0 | 4.0 | 6.6 | 4.3 | 5.0 | 4.4 | 5.4 | 5.2 | 5.4 | 5.9 | 7.5 |
| *Semitendinosus* | 6.2 | 6.3 | 6.2 | 6.7 | 6.2 | 6.8 | 6.8 | 6.8 | 5.7 | 7.7 | 6.1 | 7.1 | 7.9 | 9.1 |
| *Semimembranosus* | 7.7 | 6.3 | 6.1 | 4.6 | 4.4 | 7.0 | 4.8 | 5.0 | 4.6 | 5.8 | 7.0 | 6.1 | 5.7 | 9.4 |
| *Gluteus* | 6.7 | 7.7 | 7.2 | 5.8 | 6.2 | 6.3 | 5.4 | 5.9 | 5.5 | 6.7 | 6.1 | 5.8 | 7.1 | 9.4 |
| *Adductor* | 7.9 | 7.4 | 4.5 | 7.2 | 5.0 | 6.9 | 6.3 | 5.3 | 7.0 | 7.2 | 6.7 | 5.2 | 5.6 | 9.3 |
| *Quadriceps femoris* | 6.9 | 6.8 | 6.2 | 5.2 | 4.8 | 6.3 | 4.8 | 5.2 | 5.5 | 6.2 | 6.0 | 4.9 | 6.1 | 9.0 |
| *Gastrocnemius* | 7.2 | 6.8 | 6.3 | 6.2 | 5.7 | 7.1 | 5.6 | 5.5 | 6.6 | 6.2 | 5.9 | 6.2 | 7.2 | 8.4 |
| *Peroneus longus* | 7.2 | 7.1 | 6.8 | 6.8 | 6.4 | 7.2 | 5.4 | 5.7 | 6.2 | 7.2 | 6.4 | 6.5 | 7.5 | 8.3 |
| *Pectoralis superficialis* | 5.2 | 3.6 | 3.8 | 4.9 | 2.5 | 5.0 | 6.8 | 5.2 | 8.7 | 9.0 | 9.3 | 9.2 | 10.0 | 9.8 |
| *Pectoralis profundus* | 4.3 | 7.6 | 6.0 | 8.0 | 9.7 | 8.8 | 8.6 | 8.9 | 10.0 | 9.3 | 9.5 | 10.0 | 9.8 | 9.9 |
| *Biceps brachii* | 6.1 | 5.7 | 5.8 | 6.0 | 6.2 | 5.8 | 5.8 | 6.1 | 5.7 | 6.8 | 6.7 | 8.6 | 8.2 | 8.8 |
| *Triceps brachii* | 6.0 | 6.5 | 6.5 | 7.2 | 6.2 | 6.8 | 5.8 | 6.8 | 5.9 | 7.2 | 6.6 | 8.5 | 8.5 | 8.7 |

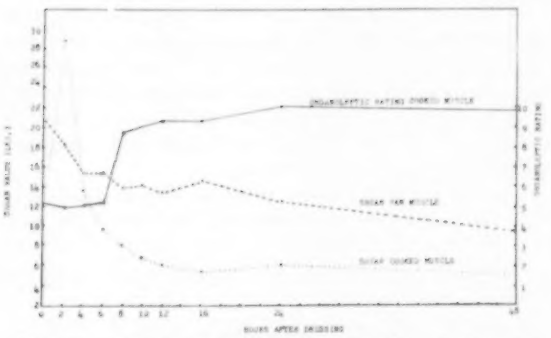

**Figure 2. Correlation between organoleptic and shear tenderness values for Pectoralis superficialis.**

An experiment was conducted to determine if freezing interfered with the observed tenderness pattern. Fifty-four birds were disjointed and only the breasts were used in this test. One-half of them, held at 4.4° C. (40° F.), served as controls. The *pectoralis superficialis* muscle was removed and cooked. The remaining half was held at 40° F. for 0, 1, 2, 3, 4, 5, 6, 16, and 24 hours before the breasts were frozen at —28.9° C. (—20° F.). After being in the freezer for 24 hours, the breasts were moved to room temperature for defrosting. Immediately after reaching

**TABLE 4**

**Tenderness values of muscles in roasted cockerels held at different time intervals after dressing prior to roasting**

| Muscle | Pounds required to shear muscles (av. 10 muscles) | | | | |
|---|---|---|---|---|---|
| | 0 hrs. | 2 hrs. | 4 hrs. | 16 hrs. | 24 hrs. |
| *Biceps femoris* | 12.6 | 13.0 | 10.1 | 8.7 | 10.7 |
| *Semitendinosus* | 10.2 | 6.7 | 6.1 | 5.9 | 4.9 |
| *Gluteus* | 10.5 | 9.6 | 8.2 | 7.7 | 6.6 |
| *Pectoralis superficialis* | 28.0 | 20.9 | 14.6 | 7.2 | 7.5 |
| *Pectoralis profundus* | 15.4 | 7.5 | 7.4 | 3.4 | 3.5 |

0.0° C. (32° F.), the *pectoralis superficialis* muscles were removed and cooked. From the results summarized in Table 5, it is apparent that, during the time the tissues were held frozen, tenderization identified with the early post-mortem period was effectively delayed. It would appear that, if a muscle is frozen before rigor is resolved, normal tenderization is delayed. Thus, it may be stated that freezing interferes with the characteristic tenderness pattern of the muscles during the early post-mortem period.

In another set of experiments, it was found the normal tenderness pattern of some muscles could be altered by cutting into the muscles excised from dispatched birds. Male broilers were used in these experiments, and shear values were secured from the 2 homologous muscles of each of three birds held for 0, 1, 2, 4, 6, 16, and 24 hours after dressing. Muscles from three other birds served as controls at each of the time intervals. It was observed that cutting into the excised muscles from dispatched birds altered the characteristic tenderness pattern of the *pectoralis superficialis* and *pectoralis profundus*. This may be

**TABLE 5**

**Tenderness values of Pectoralis superficialis muscles frozen at various time intervals after dressing**

| Hrs. held at 40° F. after dressing | Pounds required to shear cooked muscles (av. 6 muscles) | |
|---|---|---|
| | Unfrozen control muscles | Frozen muscles [b] |
| 0 | 19.6 | 20.7 |
| 1 | 21.8 | 20.7 |
| 2 | 21.2 | 16.4 |
| 3 | 14.6 | 15.3 |
| 4 | 23.7 | 14.2 |
| 5 | 18.1 | 13.9 |
| 6 | 15.9 | 14.0 |
| 16 | 8.8 | 7.0 |
| 24 | 6.5 | 6.3 |

[b] Birds held at 40° F. for various lengths of time as indicated, then held at —20° F. for 24 hours, then defrosted, cooked, and scored.

noted by reviewing data contained in Table 6. The treatment affected the tenderness pattern of the *pectoralis superficialis* and the *pectoralis profundus* muscles. Toughness presumably associated with rigor was maintained over a relatively long period of time. The cut muscles gradually became more tender within 24 hours.

In still another experiment, the tenderness values of muscles from dispatched birds immersed in warm water for different lengths of time were determined. Organoleptic values of cooked muscles were used to determine the tenderness of the muscle tissue. Five judges scored the muscles for tenderness on the basis of 1 to 10 with the latter representing the most tender muscle. Homologous muscles from three birds were studied for each time interval. Muscles considered were the *pectoralis superficialis, pectoralis profundus, quadriceps femoris,* and the *semi-tendinosus.* After being dispatched, the birds were immersed in water at 60° C. (140° F.) for 30, 60, 90, 120, and 180 seconds. The poultry was held in the cooler for 24 hours prior to removal and cooking of muscles. Table 7 shows the

**TABLE 7**

**Tenderness values of muscles from dispatched birds immersed in warm water for different lengths of time**

| Muscles | Time in seconds dispatched bird immersed in water at 140° F. and organoleptic values for cooked muscles | | | | |
|---|---|---|---|---|---|
| | 30 sec. | 60 sec. | 90 sec. | 120 sec. | 180 sec. |
| *Pectoralis superficialis* | 7.2 | 6.9 | 6.4 | 5.5 | 3.7 |
| *Pectoralis profundus* | 8.3 | 8.7 | 8.6 | 8.8 | 8.0 |
| *Quadriceps femoris* | 7.6 | 7.4 | 7.0 | 6.8 | 6.5 |
| *Semitendinosus* | 7.6 | 7.6 | 7.4 | 7.0 | 6.6 |

Least significant difference .05 level 0.78.

mean tenderness scores. It will be noted that the muscles became less tender as the time of immersion in the water increased. The bird-to-bird variance derived from the statistical analysis gave a least significant difference of 0.78 for the individual muscles. Therefore, this treatment produced significant differences in tenderness in 3 of the 4 muscles observed although the several muscles were not affected to the same degree by the

**TABLE 6**

**Tenderness values of muscles cut after being excised from dressed birds**

| Hours after dressing | Pounds required to shear muscles (av. 6 muscles) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Biceps femoris* | | *Semitendinosus* | | *Gluteus* | | *P. superficialis* | | *P. profundus* | |
| | Cut | Control | Cut | Control | Cut | Control | Cut | Control | Cut | Control |
| 0 | 10.5 | 10.7 | 8.4 | 7.8 | 7.7 | 7.2 | 29.9 | 23.5 | 16.3 | 14.5 |
| 1 | 11.0 | 9.9 | 10.8 | 6.8 | 8.3 | 8.6 | 24.8 | 20.8 | 14.0 | 10.6 |
| 2 | 9.8 | 10.7 | 7.9 | 6.0 | 7.7 | 7.8 | 27.3 | 19.4 | 13.8 | 13.1 |
| 4 | 9.7 | 10.2 | 8.1 | 7.3 | 7.9 | 9.3 | 27.0 | 14.3 | 17.9 | 10.5 |
| 6 | 9.6 | 9.3 | 7.2 | 4.8 | 6.6 | 8.0 | 29.0 | 15.7 | 17.1 | 10.3 |
| 16 | 8.8 | 9.7 | 7.8 | 6.7 | 7.5 | 7.9 | 20.1 | 12.2 | 13.2 | 10.1 |
| 24 | 8.2 | 6.9 | 7.6 | 6.0 | 8.0 | 7.7 | 14.9 | 8.9 | 9.4 | 6.2 |

treatment. The rigor pattern of the *pectoralis superficialis* seemed to be most affected.

## DISCUSSION

A tenderness pattern for the early post-mortem period was established for the principal muscles of the poultry carcass. Generally, muscles were less tender during the early post-mortem period. This less tender condition has been assumed to be associated with rigor. The muscles became tender and presumably rigor was resolved with 24 hours after the broilers were dressed.

Each muscle may be thought of as exhibiting a tenderness pattern of its own during the early post-mortem period. Some of the muscles, such as the *gastrocnemius*, did not show any great variations in tenderness during the 24-hour period following dressing. It would appear that further tendering prior to cooking which occurs after the first 24 hours is due to "aging." Since the less tender condition which appears to be identified with rigor disappears within a short time after poultry is dressed, it would seem that in the normal course of handling, the lack of tenderness associated with this early period has no particular practical significance.

It should be realized that a direct relationship between the degree of tenderness and the state of rigor has not been demonstrated. It has been assumed that a relationship does exist and that the muscles become relatively tender after rigor has been resolved. If there is a direct relationship between the lack of tenderness of these muscles and the state of rigor, it becomes apparent that there may be a pre-rigor period when muscles are relatively tender and some muscles such as the *quadriceps femoris* tend to show this as indicated in Tables 2 and 3.

In this investigation, since shear values were obtained by using whole muscles, it is not in order to compare one muscle with another because the muscles vary greatly in shape and diameter (Figure 1). It is permissible, however, to obtain a picture of the comparative tenderness of muscles by studying the organoleptic ratings (Table 3). The *pectoralis profundus* and *pectoralis superficialis* in particular became considerably more tender after what is believed to be the resolution of rigor. These muscles compose most of the white meat contained on the breast.

In these investigations, it was ascertained that freezing altered the tenderness pattern during the early post-mortem period. Freezing of the muscle during the less tender period which presumably coincides with the period of intense rigor, apparently "fixed" the state of tenderness. Freezing apparently arrests or slows down chemical reactions promoting tenderness.

The reasons for alteration of the tenderness pattern by slicing into the excised muscles from dispatched birds or by immersing birds in warm water for varying lengths of time after being dispatched are not clear. If this lack of tenderness during the early post-mortem period is directly dependent on rigor, it is entirely possible that this treatment interferes with the resolution of rigor. The mechanism for this interference is not understood but for the lack of more specific terminology may be referred to as shock.

As applied to poultry, the results reported may have no practical significance. Poultry handled under normal conditions is not consumed until after the product has been chilled and, in many instances, transported. Generally, there is sufficient time in this type of handling to allow the normal resolution of rigor and the consequent development of tenderness.

The information herein provided should shed some light on the problem of tenderness in meats. The general problem of tenderness has been and will continue to be most important to the various segments of the livestock industry.

## SUMMARY

A tenderness pattern has been indicated for many of the principal poultry muscles during the early post-mortem period. The tenderness was determined by obtaining shear readings on uncooked and cooked muscles and by obtaining organoleptic ratings on cooked muscles. Within 24 hours after poultry was dispatched, the muscles became relatively tender and some of them became relatively tender in a considerably shorter time.

Under the conditions of the experiment, freezing interfered with the tenderness pattern in that complete tenderization was delayed until the tissues were defrosted.

It was found possible to alter the tenderness pattern by cutting into muscles of dispatched birds. Under these conditions, toughness presumably associated with rigor was maintained over a relatively long period of time.

In another experiment, immersing dispatched birds in hot water for different lengths of time altered the characteristic tenderness pattern of the muscles studied. The muscles became significantly less tender as the time of immersion in water increased. In this instance, the tenderness pattern of the muscles under study was altered.

## LITERATURE CITED

1. Hanson, H. L., Stewart, G. F., and Lowe, B. Palatability and histological changes occurring in New York dressed broilers held at 1.7° C. (35° F.). *Food Research*, **7**, 148-160 (1942).
2. Koonz, C. H., and Robinson, H. E. Variations existing within the principal muscles composing the poultry carcass. (Abstract). *Poultry Sci.*, **25**, 405 (1946).
3. Lowe, B. Factors affecting palatability of poultry with emphasis on histological post-mortem changes. *Advances in Food Research*, Vol. 1, pp. 203-256. 1948, Academic Press Inc., Publishers, New York, N. Y.
4. Paul, P., Lowe, B., and McClurg, B. R. Changes in histological structure and palatability of beef during storage. *Food Research*, **9**, 221-233 (1944).
5. Ramsbottom, J. M., Strandine, E. J., and Koonz, C. H. Comparative tenderness of representative beef muscles. *Food Research*, **10**, 497-509 (1945).
6. Stewart, G. F., Hanson, H. L., Lowe, B., and Austin, J. J. Effects of aging, freezing rate, and storage period on palatability of broilers. *Food Research*, **10**, 16-27 (1945).
7. Stewart, G. F., Lowe, B., and Morr, M. Post-mortem changes in New York dressed poultry at 35° F. *U. S. Egg and Poultry Magazine*, **47**, 542-544, 571-572 (1941).
8. Warner, K. F. Progress report of the mechanical test for tenderness of meat. *Proc. Am. Soc. Animal Production for 1928*, 114-116 (1929).

# Peanut Butter. V. The Effect of Processing and Storage of Peanut Butters on the Stabilities of Their Oils

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**The stability of oils in peanut butters toward autoxidative rancidity was found to be quite high at the time of manufacture, and to remain satisfactorily high (although somewhat reduced) even after storage at 80° F. in the absence of light for two years. Neither the extent of roasting accorded the peanuts, nor the incorporation of salt or salt and hydrogenated peanut oil at levels considered in this investigation (which were not in excess of 1.5%) was found to have much effect on the stability of the oils in the peanut butter.**

**Reduction in stability, presumably occasioned by the presence of atmospheric oxygen in the head space of the jars and that incorporated with the product during processing, occurred within a relatively short period of storage. Thereafter, no further noteworthy changes in stability were observed throughout the period of storage.**

Rancidity generally refers to the development of undesirable odors and flavors from chemical change or deterioration. In vegetable oils, this deterioration is usually considered to be caused by autoxidation (oxidation by the oxygen of the air), aided by such agents as light, heat and certain metallic or organic compounds *(18)*.

Various efforts to improve the quality of peanut butter have been directed toward the prevention or retardation of rancidity. The addition of an aqueous dispersion of a wetting agent, preferably lecithin, has been claimed *(16)*, among other things, to provide an improved peanut butter which is less apt to become rancid. Incorporation of unroasted ground peanuts or crushed sesame seed in peanut butter has been suggested *(13, 14)* as a means of retarding or inhibiting rancidity. Ascorbic acid as an additive in peanut butter has been reported *(15)* "to retard the development of rancid flavor by inactivating prooxidants such as salt and traces of metals."

The purpose of this report is to show the effect of processing and storage on the autoxidative deterioration of peanut butters as indicated by the stabilities of their oils. Determinations of stabilities of oils of peanut butters were made before, and at intervals during, the storage of peanut butters which had been variously processed. Stabilities of oils *(1, 9, 18)* of peanuts and peanut products have been used to indicate the relative susceptibility of the products toward autoxidative rancidity.

## EXPERIMENTAL

**Samples.** The peanut butters used in this investigation were produced in a pilot plant at the Southern Regional Research Laboratory from No. 1 grade, shelled white Spanish peanuts *(17)* obtained from a shelling plant in southeastern United States. The peanuts were roasted to various extents in two-bag (250 lbs.) batches in a natural gas-fired, radiant-heat roaster *(3, 19)*. The roasted peanuts were cooled, mechanically blanched and manually sorted to eliminate objectionable material. Details of the roasting, blanching and sorting operations have been reported *(19)* previously.

Each batch of blanched, sorted peanuts was divided into 3 portions and ground into peanut butter without additives (Type A), with only added salt (Type B), and with added salt and hydrogenated peanut oil (m. p. ca. 64.5° C., and iodine value, 5-8) added for the prevention of oil separation (Type C). The oil contents of the various resulting peanut butters, and details as to their contents of salt and hydrogenated peanut oil have been reported *(12)* previously. Methods of incorporation of hydrogenated peanut oil *(8, 10)* in peanut butter for the prevention of oil separation have been described *(7)* by Freeman and Singleton.

The peanut butters were packaged in 8-oz. glass jars provided with lined screw caps leaving an air head space of about 45 ml. The jars of peanut butter were packed in cartons and stored on shelves in a room maintained at approximately 80° F. (26.7° C.).

**Apparatus.** The apparatus used for the determination of stabilities consists of an aerating train for washing air supplied to the samples and an electrically heated, thermostatically controlled bath to maintain a constant temperature in the test samples during aeration. Details of the aerating train and the procedure for standardization of the air-flow *(9)* have been described by King, Roschen, and Irvin.

Stability tubes with foam breakers *(4)* were used to prevent loss of oil by foaming during heating and aeration of the samples.

**Methods.** At the time of examination of a sample of peanut butter the entire contents of an 8-oz. jar were removed and mixed thoroughly to insure uniformity of the sample. The method used for the extraction of the oil from the peanut butter has been described *(11)* previously.

The stabilities were determined by the active oxygen method at 97.8° C. *(1, 9, 11)*. Procedures for determining peroxide values and stabilities were those described by Morris and Freeman *(11)*.

The stability tubes were cleaned *(5)* with a solution of Dreft[b] (50 g. of Dreft in 4000 ml. of water).

## RESULTS AND DISCUSSION

Stabilities and initial peroxide values of oils extracted from peanut butters are shown in Tables 1, 2, and 3. Stability (AOM) is reported as the number of hours of aeration and heating at 97.8° C. required by the oil to acquire a peroxide value of 100. Initial peroxide value (IPV) is expressed as milliequivalents of peroxide per kilogram of oil. For the purpose of simplifying the tables the values are grouped according to the approximate storage periods after which the samples were examined.

Table 1 shows the values obtained for the control samples of peanut butters without any additives, Type A.

Table 2 shows the values for peanut butters having salt as the only additive, Type B.

Table 3 shows the values for peanut butters containing salt and hydrogenated peanut oil, Type C.

[a] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[b] The mention of trade names in this article is for identification and implies no endorsement of the manufacturer of the product.

**TABLE 1**

**Initial peroxide values and stabilities of oils of peanut butters**
**Type A—containing no additives**

| No. | Color | Days of storage at 80° F. | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-30 | | | 40-100 | | | 100-180 | | | 180-300 | | | 300-500 | | | 500-700 | | | 700-800 | | |
| | | Age | IPV[a] | AOM[b] | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM |
| | | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* |
| 1 | very light | .... | .... | .... | .... | .... | .... | 155 | 16 | 29 | .... | .... | .... | 498 | 11 | 20 | 643 | 17 | 16½ | 768 | 5 | 23½ |
| 2 | very light | .... | .... | .... | .... | .... | .... | 138 | 4 | 39 | 303 | 6 | 25½ | 365 | 1 | 20 | 503 | 5 | 26 | .... | .... | .... |
| 3 | light | 0 | 1 | 31½ | .... | .... | .... | 134 | 11 | 21½ | 256 | 9 | 23½ | 378 | 9 | 23 | 658 | 20 | 15 | 755 | 10 | 22 |
| 4 | light | 0 | 1 | 37 | 50 | 9 | 24½ | .... | .... | .... | 237 | 18 | 18 | 358 | 7 | 23 | 538 | 23 | 15½ | 731 | 27 | 13 |
| 5 | light | 0 | 1 | 36½ | .... | .... | .... | 118 | 15 | 20 | 181 | 6 | 27½ | 377 | 5 | 25 | 638 | 6 | 26 | 730 | 8 | 28 |
| 6 | light | 0 | 0 | 26½ | .... | .... | .... | 122 | 11 | 21 | 244 | 8 | 23 | 490 | 8 | 22 | 646 | 9 | 22 | 754 | 13 | 21 |
| 7 | medium | .... | .... | .... | 77 | 6 | 31½ | .... | .... | .... | 260 | 8 | 28 | 423 | 10 | 24 | 655 | 9 | 24 | 808 | 8 | 22 |
| 8 | medium | 30 | 6 | 35 | .... | .... | .... | .... | .... | .... | 223 | 11 | 24 | 381 | 29 | 13½ | 636 | 5 | 24 | 766 | 16 | 18 |
| 9 | medium | 0 | 0 | 32 | .... | .... | .... | 132 | 10 | 21 | 254 | 10 | 22½ | 407 | 10 | 21 | 683 | 13 | 20½ | 743 | 10 | 17½ |
| 10 | medium | 0 | 0 | 36½ | .... | .... | .... | 125 | 7 | 23½ | 252 | 38 | 10½ | 408 | 12 | 21 | 611 | 7 | 21½ | 740 | 11 | 22 |
| 11 | dark | 0 | 1 | 33 | .... | .... | .... | 136 | 1 | 22 | .... | .... | .... | 436 | 8 | 22 | 685 | 6 | 25 | 773 | 4 | 24½ |
| 12 | dark | 0 | 0 | 36½ | .... | .... | .... | 125 | 12 | 20 | 246 | 9 | 23 | 394 | 5 | 25 | 595 | 11 | 20½ | 730 | 10 | 21½ |
| 13 | dark | 0 | 1 | 31 | 47 | 12 | 22½ | 78 | 11 | 25 | 243 | 7 | 25 | 370 | 8 | 22½ | 652 | 5 | 24½ | 731 | 3 | 24 |
| 14 | dark | 0 | 0 | 31½ | .... | .... | .... | 119 | 10 | 21 | 241 | 10 | 22 | 394 | 10 | 20 | 670 | 13 | 21 | 736 | 8 | 25½ |
| 15 | dark | 0 | 1 | 41 | .... | .... | .... | 111 | 8 | 27½ | 195 | 14 | 23 | 490 | 4 | 27½ | 660 | 7 | 25½ | 786 | 4 | 28 |
| 16 | dark | 0 | 1 | 35½ | .... | .... | .... | 141 | 7 | 24½ | 275 | 11 | 22 | 392 | 4 | 26 | 523 | 8 | 25 | 731 | 5 | 26½ |
| 17 | dark | 0 | 0 | 34 | 97 | 6 | 27 | .... | .... | .... | 278 | 4 | 28 | 404 | 7 | 25 | 650 | 5 | 26½ | 730 | 4 | 25 |
| 18 | very dark | .... | .... | .... | 44 | 0 | 41 | .... | .... | .... | 224 | 4 | 29½ | 414 | 3 | 20½ | 665 | 3 | 27 | 780 | 0 | 38 |
| 19 | very dark | 15 | .... | 35½ | .... | .... | .... | .... | .... | .... | 297 | 10 | 25½ | 484 | 15 | 9 | 658 | 4 | 25 | 783 | 5 | 26 |
| 20 | very dark | 12 | 0 | 45 | .... | .... | .... | 138 | 10 | 26 | 216 | 5 | 26½ | 390 | 5 | 30 | 649 | 3 | 30 | 744 | 4 | 30½ |

[a] IPV refers to the initial peroxide value of the oil before heating and aeration expressed as milliequivalents of peroxides per kilogram of oil.
[b] AOM (hours) refers to the stability of the oil expressed as the number of hours required by the oil to accumulate 100 milliequivalents of peroxides per kilogram during aeration at 97.8° C. with an air flow of 2.33 ml./sec.

In each table the batches of peanut butter are listed according to increasing extent of roasting accorded the peanuts as judged visually by increasing depth of color.

The stabilities of the oils from all samples of freshly prepared peanut butters examined, regardless of the extent of roasting accorded the peanuts, or the presence or absence of additives, were found to be quite high, the average being approximately 35 hours. These stabilities are somewhat higher than stabilities *(6)* of oils of raw shelled Spanish peanuts determined at the Southern Regional Research Laboratory. The initial peroxide values of oils from the freshly prepared peanut butters were generally low, being 1 or 0. Within 3 or 4 months substantial increases in initial peroxide values, and corresponding decreases in stabilities of the oils, were observed. Thereafter, no further noteworthy changes in stabilities were observed during the period of storage. After storage of the butters for 2 years, the stabilities of the oils were satisfactorily high, the average being approximately 23 hours.

The observed increase in peroxide values and corresponding decrease in stabilities of oils after a relatively short period of storage of peanut butters seems to indicate that oxidative changes in the oils of the peanut butters proceeded until the available supply of oxygen within each jar had been depleted. The air head space in the jars averaged approximately 45 ml. In addition, air was probably incorporated with the peanut butter during grinding.

The effect of storage on the stability of the oils of peanut butters manufactured from light roasted, medium roasted, and dark roasted peanuts is shown in Figure 1. The curves represent the stabilities of the oils from control samples (no additives) of Batch 3 (light roast), Batch 9 (medium roast), and Batch 16 (dark roast). The differences in stability are seen to be negligible for the variously roasted peanut butters at the time of manufacture and throughout the period of storage.

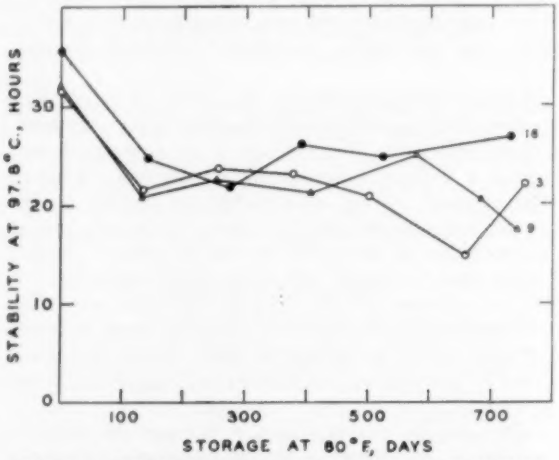


**Figure 1. Effect of storage on the stability of oils in light, medium, and dark roasted peanut butters. Curve 3 represents Type A peanut butter (control — no additives) from light roasted peanuts, Batch 3. Curve 9 represents Type A peanut butter from medium roasted peanuts. Curve 16 represents Type A peanut butter from dark roasted peanuts.**

The effect of storage on the stability of oils of peanut butters containing various additives is shown in Figure 2 for Batch 13. The stabilities of the oils of the control samples containing no additives are represented by Curve A. Stabilities of oils from peanut butters containing salt as the only additive are represented by Curve B. Stabilities of oils from peanut butters containing hydrogenated peanut oil as well as salt are represented by Curve C. Comparison of these curves show that differences are small both at the time of manufacture of the peanut butters and throughout the period of storage.

## TABLE 2

**Initial peroxide values and stabilities of oils of peanut butters**
**Type B—containing salt**

| No. | Color | Additive Salt | Days of storage at 80° F. | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0-30 | | | 40-100 | | | 100-180 | | | 180-300 | | | 300-500 | | | 500-700 | | | 700-800 | | |
| | | | Age | IPV[a] | AOM[b] | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM |
| | | % | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* |
| 1 | very light | 1.53 | .... | .... | .... | .... | .... | .... | 155 | 16 | 24 | .... | .... | .... | 498 | 12 | 19 | 643 | 8 | 19½ | 768 | 5 | 23½ |
| 2 | very light | 1.53 | .... | .... | .... | .... | .... | .... | 138 | 10 | 32 | 303 | 8 | 23 | 365 | 7 | 19½ | 638 | 13 | 20 | 755 | 8 | 23 |
| 3 | light | 1.42 | 0 | 1 | 30½ | .... | .... | .... | 134 | 11 | 21½ | 256 | 7 | 24½ | 378 | 9 | 22 | 658 | 10 | 21 | 755 | 9 | 23 |
| 4 | light | 1.42 | 0 | 1 | 38 | 50 | 10 | 23½ | .... | .... | .... | 237 | 18 | 16 | 358 | 9 | 23 | 538 | 11 | 22 | 731 | 8 | 22 |
| 5 | light | 1.42 | 0 | 1 | 39½ | .... | .... | .... | 118 | 16 | 23 | 181 | 8 | 24½ | 377 | 6 | 26 | 638 | 7 | 25 | 730 | 7 | 26½ |
| 6 | light | 1.41 | 0 | 0 | 35½ | .... | .... | .... | 122 | 8 | 22½ | 244 | 10 | 24½ | 490 | 9 | 21½ | 646 | 7 | 23 | 754 | 12 | 21 |
| 7 | medium | 1.52 | .... | .... | .... | 77 | 11 | 30 | .... | .... | .... | 260 | 9 | 27 | 423 | 11 | 21 | 655 | 10 | 23 | 808 | 8 | 22 |
| 8 | medium | 1.52 | 30 | 5 | 32½ | .... | .... | .... | .... | .... | .... | 223 | 10 | 22½ | 381 | 10 | 22½ | 636 | 9 | 22½ | 766 | 16 | 19 |
| 9 | medium | 1.44 | 0 | 0 | 34 | .... | .... | .... | 132 | 11 | 20 | 254 | 11 | 21 | 407 | 12 | 20 | 683 | 14 | 20½ | 743 | 14 | 16½ |
| 10 | medium | 1.26 | 0 | 0 | 37½ | .... | .... | .... | 125 | 7 | 24 | 252 | 6 | 23 | 408 | 8 | 23 | 611 | 8 | 22 | 740 | 14 | 21½ |
| 11 | dark | 1.42 | 0 | 1 | 32½ | .... | .... | .... | 136 | 11 | 22½ | .... | .... | .... | 436 | 8 | 23 | 685 | 6 | 24 | 773 | 3 | 24½ |
| 12 | dark | 1.39 | 0 | 0 | 32½ | .... | .... | .... | 125 | 14 | 19 | 246 | 6 | 24 | 394 | 5 | 24 | 595 | 7 | 22½ | 730 | 7 | 21 |
| 13 | dark | 1.41 | 0 | 0 | 32 | 47 | 10 | 20 | 78 | 14 | 22 | 243 | 7 | 24 | 370 | 6 | 25 | 652 | 7 | 25 | 731 | 4 | 25 |
| 14 | dark | 1.50 | 0 | 0 | 32½ | .... | .... | .... | 119 | 10 | 19 | 241 | 12 | 20½ | 394 | 11 | 21 | 670 | 12 | 20 | 736 | 12 | 23 |
| 15 | dark | 1.41 | 0 | 1 | 43 | .... | .... | .... | 111 | 10 | 26 | 195 | 15 | 22 | 490 | 5 | 27 | 660 | 6 | 25½ | 786 | 5 | 25½ |
| 16 | dark | 1.41 | 0 | 1 | 35½ | .... | .... | .... | 141 | 7 | 24½ | 275 | 11 | 21 | 392 | 0 | 27 | 523 | 13 | 19 | 731 | 3 | 27½ |
| 17 | dark | 1.41 | 0 | 1 | 35 | 97 | 5 | 25½ | .... | .... | .... | 278 | 12 | 22½ | 404 | 6 | 25 | 650 | 7 | 23 | 730 | 5 | 23½ |
| 18 | very dark | 1.51 | .... | .... | .... | 44 | 4 | 37½ | .... | .... | .... | 224 | 15 | 23½ | 414 | 5 | 23½ | 658 | 7 | 26 | 780 | 5 | 26 |
| 19 | very dark | 1.41 | 15 | .... | 39 | .... | .... | .... | .... | .... | .... | 297 | 8 | 27 | 484 | 6 | 26½ | 658 | 3 | 30 | 783 | 5 | 26½ |
| 20 | very dark | 1.51 | 12 | 0 | 45 | .... | .... | .... | 138 | 11 | 23½ | 216 | 2 | 29 | 390 | 3 | 28½ | 649 | 3 | 30 | 744 | 2 | 31 |

[a] IPV refers to the initial peroxide value of the oil before heating and aeration expressed as milliequivalents of peroxides per kilogram of oil.
[b] AOM (hours) refers to the stability of the oil expressed as the number of hours required by the oil to accumulate 100 milliequivalents of peroxides per kilogram during aeration at 97.8° C. with an air flow of 2.33 ml./sec.

## TABLE 3

**Initial peroxide values and stabilities of oils of peanut butters**
**Type C—containing salt and hydrogenated peanut oil**

| No. | Additives | | Storage at 80° F., days | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Salt | Hydrogenated peanut oil | 0-30 | | | 40-100 | | | 100-180 | | | 180-300 | | | 300-500 | | | 500-700 | | | 700-800 | | |
| | | | Age | IPV[a] | AOM[b] | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM | Age | IPV | AOM |
| | % | % | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* | *days* | | *hrs.* |
| 1 | 1.53 | 1.5 | .... | .... | .... | .... | .... | .... | 155 | 16 | 25 | .... | .... | .... | 498 | 12 | 19½ | 643 | 10 | 18½ | 768 | 7 | 19½ |
| 2 | 1.53 | 0.9 | .... | .... | .... | .... | .... | .... | 138 | 22 | 24 | 303 | 9 | 25 | 365 | 10 | 19 | 638 | 12 | 22 | 758 | 18 | 17 |
| 3 | 1.39 | 0.9 | 0 | 1 | 32½ | .... | .... | .... | 134 | 10 | 21½ | 256 | 10 | 24 | 378 | 10 | 21 | 638 | 13 | 22 | 755 | 7 | 23½ |
| 4 | 1.42 | 0.8 | 0 | 1 | 38 | 50 | 12 | 24½ | .... | .... | .... | 237 | 13 | 18½ | 358 | 6 | 25 | 538 | 9 | 23 | 731 | 16 | 19 |
| 5 | 0.93 | 0.93 | 0 | 5 | 31½ | .... | .... | .... | 118 | 16 | 19 | 181 | 10 | 21½ | 377 | 5 | 24 | 638 | 9 | 24 | 730 | 9 | 21½ |
| 6 | 1.39 | 1.2 | 0 | 0 | 32 | .... | .... | .... | 122 | 7 | 24 | 244 | 6 | 25 | 491 | 8 | 22½ | 646 | 14 | 19½ | 754 | 15 | 20½ |
| 7 | 1.3 | 1.3 | .... | .... | .... | 77 | 17 | 26½ | .... | .... | .... | 260 | 12 | 24½ | 423 | 13 | 20 | 660 | 5 | 23½ | 808 | 9 | 19 |
| 8 | 1.3 | 1.3 | 30 | 8 | 30½ | .... | .... | .... | .... | .... | .... | 223 | 51 | 7½ | 381 | 22 | 18½ | 638 | 4 | 25½ | 776 | 16 | 23½ |
| 9 | 1.25 | 1.7 | 0 | 0 | 35 | .... | .... | .... | 132 | 7 | 21½ | 254 | 8 | 21 | 407 | 11 | 22 | 683 | 16 | 21 | 743 | 15 | 18 |
| 10 | 1.23 | 0.8 | 0 | 0 | 36½ | .... | .... | .... | 125 | 7 | 24 | 252 | 10 | 22 | 408 | 5 | 25 | 612 | 10 | 21 | 740 | 12 | 22½ |
| 11 | 1.4 | 1.4 | 0 | 13 | 23 | .... | .... | .... | 136 | 43 | 9 | .... | .... | .... | 436 | 9 | 23 | 689 | 8 | 22 | 773 | 5 | 22 |
| 12 | 1.3 | 0.3 | 0 | 0 | 36 | .... | .... | .... | 125 | 17 | 23 | 246 | 4 | 26½ | 394 | 3 | 26 | 595 | 4 | 25 | 730 | 19 | 18 |
| 13 | 1.4 | 0.8 | 0 | 0 | 33 | 47 | 10 | 21½ | 78 | 16 | 21 | 243 | 7 | 23½ | 370 | 5 | 25½ | 652 | 9 | 22 | 731 | 8 | 23 |
| 14 | 1.5 | 0.9 | 0 | 0 | 32 | .... | .... | .... | 119 | 6 | 22 | 241 | 8 | 22 | 394 | 13 | 18 | 670 | 11 | 21½ | 736 | 5 | 26 |
| 15 | 1.5 | 1.5 | 0 | 13 | 25½ | .... | .... | .... | 111 | 12 | 22½ | 195 | 13 | 22 | 490 | 5 | 25 | 660 | 11 | 25 | 786 | 4 | 25 |
| 16 | 1.38 | 0.97 | 0 | 1 | 36½ | .... | .... | .... | 141 | 9 | 24½ | 275 | 9 | 26½ | 392 | 0 | 27 | 523 | 5 | 26 | 731 | 4 | 29 |
| 17 | 1.5 | 1.5 | 0 | 1 | 33 | 97 | 6 | 27½ | .... | .... | .... | 278 | 4 | 27 | 404 | 9 | 23 | 650 | 4 | 25½ | 730 | 3 | 25 |
| 18 | 1.2 | 1.2 | .... | .... | .... | 44 | 10 | 30 | .... | .... | .... | 224 | 21 | 20½ | 426 | 43 | 10 | 661 | 42 | 8½ | 780 | 3 | 26 |
| 19 | 1.41 | 1.5 | 15 | .... | 42 | .... | .... | .... | .... | .... | .... | 297 | 6 | 27½ | 484 | 5 | 28 | 658 | 2 | 26½ | 783 | 9 | 24 |
| 20 | 1.4 | 1.4 | 12 | 0 | 36 | .... | .... | .... | 139 | 21 | 17½ | 216 | 17 | 16¾ | 390 | 37 | 12 | 649 | 4 | 26½ | 744 | 4 | 27 |

[a] IPV refers to the initial peroxide value of the oil before heating and aeration expressed as milliequivalents of peroxides per kilogram of oil.
[b] AOM (hours) refers to the stability of the oil expressed as the number of hours required by the oil to accumulate 100 milliequivalents of peroxides per kilogram during aeration at 97.8° C. with an air flow of 2.33 ml./sec.

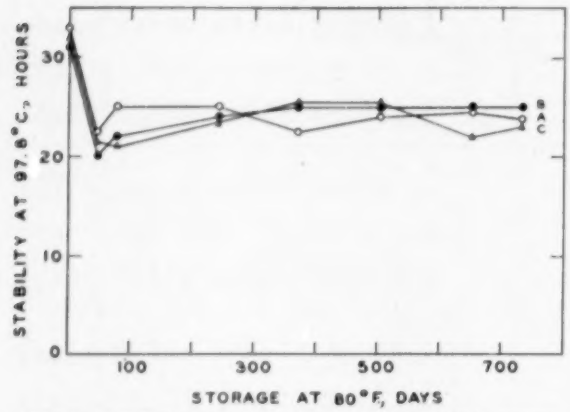


**Figure 2. Effect of storage on the stability of oils in peanut butters (Batch 13), containing various additives: (A) Control —no additives. (B) Containing salt. (C) Containing salt and hydrogenated peanut oil.**

Bailey has pointed out *(2)* that the free fatty acid content of a fat is not, as sometimes is supposed, an indication of the presence or absence of rancidity. Although the development of free fatty acids in a fat and the development of rancidity are not related, it may be of interest that, for all of the peanut butters on which stability data are given in this report, the free fatty acid contents of the oils were uniformly low (ca. 0.2%) at the time of manufacture *(12)*, both for the raw peanuts and for the resulting peanut butters. It has also been found that the free fatty acids contents of the oils of these peanut butters[c] did not change significantly during the period of storage.

## SUMMARY

The stability of oils in peanut butters toward autoxidative rancidity was found to be quite high at the time of manufacture, and to remain satisfactorily high (although reduced) even after storage at 80° F. in the absence of light for 2 years. Neither the extent of roasting accorded the peanuts, nor the incorporation of salt or salt and hydrogenate[d] peanut oil at levels considered in this investigation (which were not in excess of 1.5%) was found to have much effect on the stability of the oils in the peanut butters.[d]

[c] Unpublished data.

[d] The effect of processing and storage on the flavor characteristics of these peanut butters has been determined by a taste panel and will be presented in another paper.

Reduction in stability, presumably occasioned by the presence of atmospheric oxygen in the head space of the jars and that incorporated with the product during processing, occurred within a relatively short period of storage. Thereafter, no further noteworthy changes in stability were observed throughout the period of storage.

## LITERATURE CITED

1. American Chemical Society. Report of the Committee on the Analysis of Commercial Fats and Oils. V. C. Mehlenbacher, Chairman. *Ind. Eng. Chem., Anal. Ed.*, **17**, 336 (1945).
2. Bailey, A. E. *Industrial Oil and Fat Products.* 1945, Interscience Publishers, Inc., New York, N. Y., page 44.
3. Beattie, W. R. Making and using peanut butter. U. S. Dept. Agr., *Circ., 384* Rev. (1941).
4. Fisher, G. S., and Morris, N. J. Stability tube with foam breaker. *Anal. Chem.*, **24**, 1384 (1952).
5. Fore, Sara P., Moore, R. N., and Bickford, W. G. Improved procedure for cleaning glassware used in determining the stability of fats and oils by the active oxygen method. *J. Am. Oil Chem. Soc.*, **28**, 73 (1951).
6. Fore, S. P., Morris, N. J., Mack, C. H., Freeman, A. F., and Bickford, W. G. Factors affecting the stability of crude oils of sixteen varieties of peanuts. *J. Am. Oil Chem. Soc.*, **30**, 298 (1953).
7. Freeman, A. F., and Singleton, W. Sidney. Prevention of oil separation in peanut butter—a review. *Peanut Journal and Nut World*, **31** (4), 23 (1952).
8. Holman, George W., and Quimby, Oscar T. (to the Procter and Gamble Company), U. S. Patent 2,521,219 (September 5, 1950).
9. King, A. E., Roschen, H. L., and Irwin, W. H. An accelerated stability test using the peroxide value as an index. *Oil & Soap*, **10**, 105 (1933).
10. Mitchell, J. P., Jr. (to the Procter and Gamble Company), U. S. Patent 2,521,242 (September 5, 1950).
11. Morris, Nelle J., and Freeman, A. F. Determination of stabilities of crude peanut oils by accelerated aeration methods. *Food Technol.*, **7**, 227 (1953).
12. Morris, N. J., Willich, R. K., and Freeman, A. F. Peanut butter. III. Effect of roasting, blanching and sorting on the contents of oil and free fatty acids of peanuts. *Food Technol.*, **7**, 366 (1953).
13. Musher, Sidney. U. S. Patent 1,816,338 (July 28, 1931).
14. Musher, Sidney. U. S. Patent 2,198,220 (April 23, 1940).
15. Owen, J. T. Ascorbic acid combats rancidity in peanut butter. *Glass Packer*, **26**, 914 (1947).
16. Rosefield, J. L., Rosefield, J. M., and Rosefield, M. U. S. Patent 2,397,564 (April 2, 1946).
17. Southeastern Peanut Association, Americus, Georgia. Official Rules of Southeastern Peanut Association. Adopted and revised June 20, 1950.
18. Wheeler, D. H. Peroxide formation as a measure of autoxidative deterioration. *Oil & Soap*, **9**, 89 (1932).
19. Willich, R. K., Hall, A. S., Morris, N. J., and Freeman, A. F. Peanut butter. I. Roasting, cooling, blanching, and picking of peanuts. *Food Technol.*, **6**, 71 (1952).

# Sampling Deliveries of Grapes on a Representative Basis

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(Manuscript received June 29, 1953)

**A study was made of the requirements of an adequate sampling technique for grapes delivered to wineries in boxes and in bulk. It was found that a composite of 5-pound samples from each of 14 boxes gave an average deviation of 0.57° Brix from the mean of loads of 180-220 boxes. In bulk sampling 5 samples of 10 pounds each taken according to a specified pattern gave a maximum deviation of 0.5° Brix from the mean of 4-10 ton loads in 98% of the loads tested. Variety of grape was found to affect the sampling requirements.**

It is common practice in the California wine industry to purchase grapes on the basis of the total soluble solids

content of the expressed juice. Grapes are received by the wineries either in gondola tanks as a bulk shipment or in 50-pound lug boxes hauled by trucks. The gondolas are from 3 to 4 feet high, 8 feet wide, and from 8 to 16 feet long, and contain from 4 to 10 tons of grapes. The boxed grapes are usually arranged on the truck bed in 4 rows either 5 or 6 high and averaging 200 boxes per load.

In the presently used gondola-sampling procedure, a sample of approximately 10 pounds is taken by means of a tube driven vertically once through the load. In box sampling approximately 5 pounds of grapes are selected at random from several of the top boxes. Size of load receives little or no consideration.

Such methods for obtaining a representative composite of the load cannot be justified on the basis of previous investigation on sampling procedures *(1)* and the statistical study of the data secured *(3)*. A study was therefore conducted during the 1952 vintage to determine the weight and number of samples required and the degree of randomization necessary to establish an adequate sampling technique for grapes delivered by either of the methods described.

## EXPERIMENTAL PROCEDURE

Procedures for sampling from deliveries made in boxes or gondolas were tested. The experiments on box sampling were established at a winery in a district where most of the grapes were delivered in boxes. The gondola tests were conducted at a winery in a district where the majority of grapes were received in gondolas. At both wineries tests were made daily 5 days per week during the vintage season.

**Box-sampling procedure.** This procedure was divided into 3 phases. In the first phase the variation in degrees Brix between boxes was determined in a 20-box sample. The boxes were removed from the rear of the load, each box was crushed separately, and the degree Brix was determined. The average degree Brix of successive numbers of boxes, grouped in the order sampled, was then calculated and compared with the average Brix degree of the 20 boxes.

In the second phase, the variation in degrees Brix between a composite of 5-pound samples selected from each of 8 boxes and the average degree Brix of the whole 8 boxes was determined. Each box was dumped in turn onto a table, and approximately 5 pounds were selected rapidly in the proportion of green and ripe which the sampler on quick visual inspection decided was representative of the box. The samples selected were crushed together and the juice tested for soluble-solids content. The remaining grapes in each box were then crushed, and the soluble-solids content of the juice from each box was determined separately. The average degree Brix of the composited 5-pound samples plus the remaining grapes in the 8 boxes was calculated. The Brix degree of the composited 5-pound samples was then compared with the average Brix degree of the 50-pound boxes. This phase was conducted to determine if weight of samples could be reduced from 50 pounds to 5 pounds.

In the third phase, 5 complete loads of 180-220 boxes each were crushed. The degree Brix of each box was determined, and the average Brix degree of 20 box units, grouped in the order sampled, was calculated. This phase was designed to determine the variation of 20-box units within the load.

**Gondola-sampling procedure.** The samples were taken at the sampling positions shown in Figure 1. The sampling pattern was determined by dividing the gondola compartment into 4 equal quadrants (A, B, C, D) and spacing sampling positions 1, 2, 3, and 4 equidistant from the sides of the quadrants, with position 5 equidistant from the other 4 positions. Position E was fixed by the point at which the 4 quadrants met.

A total of 21 samples were taken from each gondola by a sampling tube driven vertically through the load to the floor of the tank. The samples, which averaged 10 pounds each, were crushed individually and tested for soluble-solids content. The average Brix degree of various combinations of samples was then calculated and compared with the average Brix degree of the 21 samples.

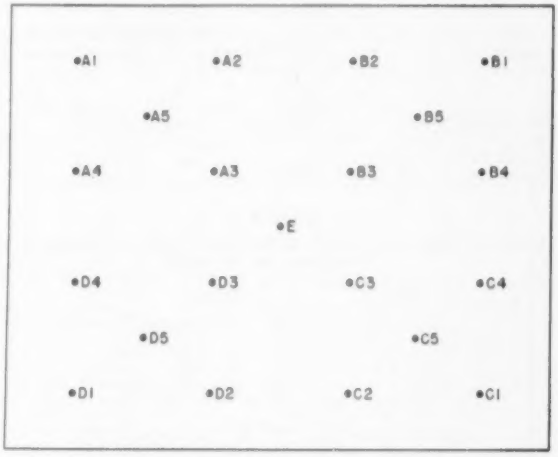


**Figure 1. Gondola sampling pattern.**

**Soluble-solids determination.** In both box and gondola sampling the grapes were crushed by passage of the whole cluster between two corrugated, spring-loaded rollers driven by a ½ H.P. motor. In box sampling, the juice was screened from the stems and pomace by a screen-bottom drag conveyor, which discharged the juice from the false bottom into a bucket. In gondola sampling, the juice was separated from the pomace by shaking in a round screen placed over a shallow pan. After thorough stirring of the contents of the bucket or pan a 100-ml. sample was removed for analysis. The total soluble solids were determined with an Abbe refractometer scaled to read directly in degrees Brix. The prisms were maintained at constant temperature with flowing water. All readings were made within a few minutes after crushing and were corrected to 20° C. Deaeration of the must prior to Brix determinations was not deemed necessary for this study. The refractometer readings were reproducible to ± 0.1° Brix. Approximately the same variation was found between successive 100-ml. samples taken from the same lot of juice.

Since wineries customarily use hydrometers for the determination of the soluble-solids content of musts, a comparison of the hydrometer with the refractometer is given in order to relate the findings in this study to usual winery practice. Determination of the soluble-solids contents of 156 undeaerated musts by both the refractometer and hydrometer gave a deviation range between the 2 instruments of 0.0° to 1.0° Brix and a standard deviation of 0.155°. Deaeration of the must would quite probably yield closer agreement between the results obtained with the 2 instruments *(5)*.

Data secured at the established field stations were subjected to statistical analyses, and the results obtained are presented for review in summarized tabular form (Tables 1-10, inclusive). It was the purpose of the statistical analyses to determine the number and weight of samples from box loads and the number, weight, and sampling position of samples from gondola loads that would give a representative sample with a variation not exceeding plus or minus 0.5° Brix.

**Box sampling.** The first phase of the work is reported in Tables 1 and 2. The range in degrees Brix for the individual boxes in all loads, and the maximum and minimum variation in degrees Brix between the individual boxes in the 20-box lots, termed the spread, is given in Table 1. The range of deviation from the average degree Brix of the 20 boxes as affected by the number of samples taken is presented in Table 2. It indicates that a 9-box sample fulfills the specified conditions (variation from average not greater than ± 0.5° Brix) for the Mission variety, that 10 boxes would be required as a sample for Palomino, 11 for Burger, 12 for Carignane and Tokay, and 14

**TABLE 1**
**Range and spread in degrees Brix of individual boxes**

| | Variety | | | | | |
|---|---|---|---|---|---|---|
| | Burger | Carignane | Mission | Palomino | Tokay | Zinfandel |
| No. of loads | 20 | 21 | 20 | 15 | 39 | 22 |
| Range for all loads | 14.5-20.1 | 16.5-25.2 | 19.0-25.6 | 18.0-23.0 | 14.0-22.5 | 12.2-26.5 |
| Spread within 20-box units | 2.0-4.0 | 1.9-4.8 | 1.8-4.2 | 1.8-3.8 | 2.2-4.8 | 2.1-6.4 |
| Average spread within 20-box units | 2.8 | 3.1 | 3.1 | 2.6 | 3.3 | 3.7 |

**TABLE 2**
**Effect of number of boxes on deviation range in degrees Brix from mean of 20 boxes**

| No. of boxes | Variety | | | | | |
|---|---|---|---|---|---|---|
| | Burger | Carignane | Mission | Palomino | Tokay | Zinfandel |
| 1 | 1.1-2.2 | 1.1-2.8 | 1.1-3.2 | 0.9-2.2 | 1.1-3.1 | 1.2-3.5 |
| 3 | 0.3-1.4 | 0.2-1.5 | 0.5-1.5 | 0.3-1.0 | 0.5-2.4 | 0.4-2.1 |
| 4 | 0.2-1.2 | 0.3-1.1 | 0.4-1.0 | 0.2-1.1 | 0.3-2.0 | 0.3-2.1 |
| 5 | 0.1-0.9 | 0.2-0.9 | 0.1-0.8 | 0.1-0.8 | 0.2-1.7 | 0.2-1.4 |
| 6 | 0.1-1.0 | 0.1-0.8 | 0.2-0.7 | 0.1-0.7 | 0.1-1.4 | 0.2-1.7 |
| 7 | 0.1-0.9 | 0.0-0.7 | 0.1-0.7 | 0.1-0.6 | 0.1-0.9 | 0.1-1.2 |
| 8 | 0.1-0.8 | 0.1-0.6 | 0.1-0.9 | 0.1-0.7 | 0.1-1.2 | 0.1-1.5 |
| 9 | 0.0-0.8 | 0.0-0.5 | 0.1-0.5 | 0.0-0.7 | 0.1-1.1 | 0.1-1.3 |
| 10 | 0.0-0.7 | 0.1-0.6 | 0.0-0.5 | 0.0-0.5 | 0.0-0.8 | 0.1-1.2 |
| 11 | 0.0-0.3 | 0.0-0.6 | 0.0-0.4 | 0.0-0.7 | 0.0-0.7 | 0.0-1.0 |
| 12 | 0.0-0.3 | 0.0-0.5 | 0.0-0.4 | 0.0-0.3 | 0.0-0.5 | 0.0-0.9 |
| 13 | 0.0-0.3 | 0.0-0.4 | 0.0-0.3 | 0.0-0.2 | 0.0-0.4 | 0.0-0.6 |
| 14 | 0.0-0.3 | 0.0-0.3 | 0.0-0.3 | 0.1-0.2 | 0.0-0.4 | 0.0-0.4 |

for Zinfandel. If variety is to be disregarded, the minimum required would be 14 boxes.

Statistical data secured in the second phase of the box-sampling tests, in which the object was to determine if the weight of sample could be reduced, are summarized in Table 3. These data show that the Brix degree of 5-pound samples, selected from a series of 8 boxes according to the proportion of green and ripe and composited, rather closely approaches the mean of the 8-box sample. The maximum deviation from the average degree Brix of the samples as a whole was below 0.5° for all except 2 varieties, Tokay and Zinfandel. Though the average deviation of these 2 varieties from the mean is low, the percentage of the samples exceeding 0.5° Bris is appreciable, especially in the case of Zinfandel.

The third phase of the box sampling study is reported in Table 4. In this phase the mean of the Brix readings obtained for units of 20 boxes was compared with the mean of the Brix readings obtained for the entire number of boxes in the load. The range of deviation of the 20-box unit from the average for the load indicates that the selection of a 20-box unit to represent the entire load in the other phases of the work was valid. Although this phase was conducted solely with the Tokay variety, it is quite probable that based upon the deviation shown the 20-box unit is equally representative of the entire load of other varieties.

**TABLE 3**
**Comparison of the degree Brix of the composited 5-pound samples with the average degree Brix of the 8 boxes**

| | Variety | | | | | |
|---|---|---|---|---|---|---|
| | Burger | Carignane | Mission | Palomino | Tokay | Zinfandel |
| No. of samples | 40 | 14 | 40 | 30 | 78 | 16 |
| Deviation range | 0.0-0.3 | 0.1-0.4 | 0.0-0.4 | 0.0-0.4 | 0.0-0.7 | 0.0-0.7 |
| Average deviation | 0.14 | 0.21 | 0.15 | 0.20 | 0.19 | 0.16 |
| % of samples exceeding 0.5° Brix | 0.0 | 0.0 | 0.0 | 0.0 | 2.6 | 6.2 |

**TABLE 4**
**Comparison of average degree Brix of 20-box units of Tokays with average degree Brix of the entire load**

| Load no. | No. of boxes | Deviation range | Average deviation |
|---|---|---|---|
| 1 | 220 | 0.1-0.5 | 0.23 |
| 2 | 200 | 0.0-0.5 | 0.33 |
| 3 | 180 | 0.0-0.4 | 0.22 |
| 4 | 180 | 0.1-0.5 | 0.29 |
| 5 | 180 | 0.0-0.6 | 0.27 |
| Average | | | 0.27 |

Table 5 shows the average and maximum deviations possible if composited 5-pound samples from the indicated number of boxes are used as a measure of the mean of 180-220 box loads. It also gives the probabilities of exceeding the average deviations and of equaling the maximum deviations. If composited 5-pound samples were used, the average deviation from the mean of 0.57° Brix would be exceeded in less than 5% of the loads, and in less than 0.2% of the loads would the maximum deviation of 1.4° Brix be attained.

Table 6 gives the maximum deviation in degrees Brix of averages of single boxes from averages of the means of 20-box lots. This table shows that the maximum deviation is less than 0.6° Brix for all 6 varieties when 10 or more lots are grouped. Though a single box sample can deviate as much as 3.5° Brix from the mean of 20 boxes, if 10 lots are averaged a single box sample from each of the lots would be adequate to assure a deviation not greater than ± 0.5° Brix from the mean of the 10 lots.

It is interesting to calculate the deviation of averages of single boxes from the averages of means in loads of 180 to 200 boxes. If we assume that the maximum deviation given in Table 4 applies to all varieties, then the maximum deviations for the average of the 6 varieties are 1.3° Brix for 5 loads, 0.8° for 10, and 0.7° for 15. Similarly the chances of exceeding a maximum deviation of ± 0.5° Brix are 1 in 14 for 10 loads, and 1 in 36 for 15. Thus some number of loads greater than 15 would have to be averaged before the deviation of the mean of single-box samples from the mean of the loads would not exceed ± 0.5° Brix.

**Gondola sampling.** The spread in degrees Brix between the samples withdrawn for testing from the gondola deliveries as influenced by variety is shown in Table 7. The number of loads tested and the maximum and minimum Brix degree recorded for each of the 5 varieties is also shown in the table. The range for these varieties is similar to those used in securing the data in the box sampling procedure.

Tables 8 and 9 show the effect of sampling position and number of samples on the variation of sample combinations from

**TABLE 5**
**Possible average and maximum deviations in degrees Brix of composited 5-pound samples from mean of the whole load and the probabilities of exceeding or equaling these deviations**

| | Variety | | | | | | |
|---|---|---|---|---|---|---|---|
| | Burger | Carignane | Mission | Palomino | Tokay | Zinfandel | Ave. |
| Possible average deviation [a] | 0.51 | 0.59 | 0.52 | 0.58 | 0.59 | 0.59 | 0.57 |
| Probability of exceeding | 1/20.8 | 1/29.4 | 1/17.9 | 1/62.5 | 1/14.4 | 1/16.0 | 1/20.9 |
| Possible maximum deviation [a] | 1.2 | 1.3 | 1.3 | 1.2 | 1.7 | 1.7 | 1.4 |
| Probability of equaling | 1/500 | 1/1470 | 1/2000 | 1/281 | 1/15210 | 1/653 | 1/726 |

[a] Based on deviation of average of 14 boxes from the mean of 20 boxes, on the assumption that deviation of composited 5-pound samples from the mean of 8 boxes would be the same for 14 boxes, and on the assumption that the deviations found for the 5 loads of Tokays would be the same for the other varieties.

**TABLE 6**

**Maximum deviation in degrees Brix of averages of single boxes from averages of the means of 20-box lots**

| Number [b] | Variety | | | | | | |
|---|---|---|---|---|---|---|---|
| | Burger | Carignane | Mission | Palomino | Tokay | Zinfandel | Ave. |
| 5 | 0.6 | 0.5 | 0.8 | 0.5 | 0.8 | 0.7 | 0.7 |
| 10 | 0.3 | 0.2 | 0.5 | 0.2 | 0.1 | 0.1 | 0.2 |
| 15 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

[b] Number of 20-box-lot means averaged for comparison with averages of the No. 1 boxes from the same lots.

**TABLE 7**

**Range and spread in degrees Brix of individual samples from gondola loads**

| | Variety | | | | |
|---|---|---|---|---|---|
| | Alicante Bouschet | Emperor | Muscat of Alexandria | Thompson Seedless | White Malaga |
| No. of loads | 19 | 24 | 45 | 20 | 51 |
| Range for all loads | 16.8-26.4 | 14.0-19.7 | 18.5-28.5 | 17.5-25.1 | 15.3-22.0 |
| Spread within loads | 1.1-5.0 | 0.8-5.1 | 1.0-7.4 | 1.1-4.8 | 0.7-4.6 |
| Average spread within loads | 2.6 | 1.7 | 3.0 | 2.4 | 2.0 |

the mean of the 21 samples. Five sampling combinations or patterns composed of 4 samples each and 5 of 5 samples each are compared in these tables. As an example of the combinations, sampling pattern A-D 1 is composed of 4 samples, one each of which was taken from the No. 1 position in quadrants A, B, C, D; and sampling pattern A-D 1 + E is composed of 5 samples, one each from the No. 1 position in quadrants A, B, C, D, plus one sample from the E position. The data in these tables indicate that both the variety of grape and sampling pattern used affect the accuracy of the results obtained. On the assumption that a 0.5° Brix deviation provides sufficient accuracy, sampling each quadrant at the fifth or central position by pattern A-D or A-D + E is satisfactory for all varieties except Muscat of Alexandria. However, the A-D + E pattern is preferable because with this variety it gives a maximum deviation of 0.7° Brix for 2 loads, compared with 0.9° for the A-D pattern.

Table 10 gives the maximum deviation in degrees Brix of the mean of single samples from the mean of gondola loads. With 4 loads the maximum deviation is 0.5° Brix. Though a single sample can deviate as much as 6.1° Brix from the mean of the load, if 4 loads are averaged a single sample taken at the E position from each would be adequate to assure a deviation not greater than ± 0.5° Brix from the mean of the 4 loads.

**TABLE 8**

**Effect of gondola sampling patterns on deviation range in degrees Brix from mean of 21 samples**

| Pattern | Variety | | | | |
|---|---|---|---|---|---|
| | Alicante Bouschet | Emperor | Muscat of Alexandria | Thompson Seedless | White Malaga |
| A-D | | | | | |
| 1 | 0.0-0.9 | 0.0-0.6 | 0.0-1.4 | 0.0-0.5 | 0.0-0.8 |
| 2 | 0.0-0.6 | 0.0-0.5 | 0.0-0.9 | 0.0-0.4 | 0.0-1.0 |
| 3 | 0.0-0.8 | 0.0-0.5 | 0.0-1.1 | 0.0-1.1 | 0.0-0.5 |
| 4 | 0.0-0.6 | 0.0-0.9 | 0.0-0.9 | 0.0-0.4 | 0.0-0.6 |
| 5 | 0.0-0.5 | 0.0-0.4 | 0.0-0.9 | 0.0-0.5 | 0.0-0.5 |
| A-D + E | | | | | |
| 1 | 0.0-0.8 | 0.0-0.5 | 0.0-1.0 | 0.0-0.5 | 0.0-0.6 |
| 2 | 0.0-0.4 | 0.0-0.4 | 0.0-0.7 | 0.0-0.3 | 0.0-0.8 |
| 3 | 0.0-0.6 | 0.0-0.4 | 0.0-0.8 | 0.0-0.7 | 0.0-0.6 |
| 4 | 0.0-0.5 | 0.0-0.6 | 0.0-0.6 | 0.0-0.4 | 0.0-0.6 |
| 5 | 0.0-0.4 | 0.0-0.5 | 0.0-0.7 | 0.0-0.4 | 0.0-0.5 |

## DISCUSSION

Variety appears to exert a considerable influence on the size of the sample required to provide a satisfactory accuracy. Those that tend to ripen unevenly, or "second crop," require a larger sample to attain a given degree of accuracy. "Raisining" would undoubtedly exert a similar influence. It would appear from the data presented that accurate sampling becomes a real problem in all varieties tending toward an average spread of 3.0° Brix or greater. These different varietal growth responses seriously complicate the problem and must of necessity be considered in establishing sampling requirements for either loads of boxes or gondola shipments. From the data presented, at least 14 boxes should be sampled from loads of 180-200 boxes, and at least 5 samples of 10 pounds each are required from gondola loads (taken according to one specific sampling pattern) to obtain a deviation of not over 0.5° Brix from the average Brix of the load. This is very close to the square root of the total number of containers in the lot, which some authorities *(2)* are using at the present time for the purpose of securing a representative sample. The size of the sample found necessary is a great deal larger than that taken in the presently used industry-sampling procedure. This study has demonstrated that present sampling procedures can result in a maximum deviation from the mean of 3.5° Brix in the case of box sampling, and 6.1° in gondola sampling.

It should be stressed, however, that all the samples taken from a load of boxes were from one location in the load. As a matter of convenience, these were always boxes from the rear of the load. Randomization in the selection of the boxes quite probably would reduce the number of boxes required to be within the specified deviation. In tomato sampling, where sample selection is made according to a carefully randomized plan, approximately one half the square root of the total number of containers is considered adequate *(4)*.

It is worthy of note that there is no apparent relationship between size of gondola and the accuracy achieved by the various sampling patterns. The patterns used give substantially the same results in gondolas ranging from 8 to 16 ft. in length.

The authors wish to stress the fact that their study

**TABLE 9**

**Effect of gondola sampling patterns on percent of loads exceeding 0.5° Brix deviation from mean of 21 samples**

| Pattern | Variety | | | | | |
|---|---|---|---|---|---|---|
| | Alicante Bouschet | Emperor | Muscat of Alexandria | Thompson Seedless | White Malaga | Average |
| A-D | | | | | | |
| 1 | 15.7 | 4.2 | 8.9 | 0.0 | 5.9 | 6.9 |
| 2 | 5.3 | 0.0 | 4.4 | 0.0 | 5.9 | 3.8 |
| 3 | 5.3 | 0.0 | 11.1 | 5.0 | 0.0 | 4.4 |
| 4 | 10.5 | 4.2 | 8.9 | 0.0 | 1.7 | 5.0 |
| 5 | 0.0 | 0.0 | 4.4 | 0.0 | 0.0 | 1.3 |
| A-D + E | | | | | | |
| 1 | 10.5 | 0.0 | 11.1 | 0.0 | 2.0 | 5.0 |
| 2 | 0.0 | 0.0 | 4.4 | 0.0 | 2.0 | 1.9 |
| 3 | 5.3 | 0.0 | 4.4 | 5.0 | 2.0 | 3.1 |
| 4 | 0.0 | 4.2 | 8.8 | 0.0 | 2.0 | 3.8 |
| 5 | 0.0 | 0.0 | 6.7 | 0.0 | 0.0 | 1.9 |
| Aver. | 5.3 | 1.3 | 9.4 | 1.0 | 2.2 | 3.7 |

**TABLE 10**

**Maximum deviation in degrees Brix of averages of single samples from averages of gondola loads**

| Number [c] | Variety | | | | | Percent exceeding 0.5° Brix deviation |
|---|---|---|---|---|---|---|
| | Alicante Bouschet | Emperor | Muscat of Alexandria | Thompson Seedless | White Malaga | |
| 2 | 0.6 | 0.5 | 0.6 | 0.4 | 0.6 | 6.2 |
| 3 | 0.4 | 0.3 | 0.4 | 0.5 | 0.6 | 3.3 |
| 4 | 0.4 | 0.2 | 0.4 | 0.3 | 0.5 | 0.0 |

[c] Number of gondola loads averaged for comparison with averages of the E samples from the same loads.

has not solved all the problems involved in grape sampling. On the contrary, it has raised a number of questions that must be answered before all the requirements of an accurate grape-sampling system can be specified. These are: effect on variability of time of harvesting, season, and region; effect of randomization in selection of sample; and the variability of varieties other than those studied. However, it is believed that the data presented point out the inadequacies of the presently used industry-sampling procedures and give some indication of the requirements of an accurate sampling method.


## SUMMARY

For the 6 varieties studied a 20-box sample was found to deviate 0.0°-0.6° Brix from the mean of loads of 180-220 boxes. Depending upon the variety, 9-14 boxes are required as a sample to assure a deviation of not over 0.5° Brix from the mean of a 20-box lot. A composite of selected 5-pound samples from each of 8 boxes deviated 0.0°-0.7° Brix from the mean of 8 boxes. If a composite of selected 5-pound samples from each of 14 boxes is used as a measure of the true mean of loads of 180-220 boxes the possible average deviation was found to be 0.57° and the possible maximum deviation 1.4° Brix, with the probability of exceeding the average deviation 1/20.9 and the probability of equaling the maximum deviation 1/726. If only a single box sample is taken from each of the loads between 15 and 20 loads must be averaged to assure a deviation not greater than ± 0.5° Brix from the mean.

In bulk sampling, for the 5 varieties studied, a composite of 5 samples of 10 pounds each taken according to one specific sampling pattern was found to deviate 0.0°-0.7° Brix from the mean of a gondola load of grapes. If 4 loads are averaged a composite of single 10-pound samples taken at the E position from each of the loads will not deviate more than 0.5° Brix from the mean of the 4 loads.


## LITERATURE CITED


1. Amerine, M. A. (Private communication, 1952).
2. Howard, B. J. Walnut testing. *Pamphlet.* Bureau Food and Drug Administration, U. S. Dept. Agr., p. 7. (1930).
3. Marsh, G. L. Sugar sampling method for grapes for crushing. *Mimeo.* 2 p. Wine Institute, San Francisco (1952).
4. Whipple, S. R. A representative sample. Calif. State Dept. Agr. *Bull.*, **37**, 23-24, 1948.
5. Whipple, S. R. (Private communication, 1952).



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# Frozen Apple Juice Concentrate: Permissible Temperatures for Concentration of Western Varieties of Apples


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**Results of investigations concerning effects of various temperatures during concentration upon changes in flavor of juices from various varieties of Western apples are reported and discussed.**


During concentration of fruit juices *in vacuo*, an important consideration affecting product quality is that of the maximum allowable temperature and hence pressure in the concentrator which will not result in heat-induced flavor changes in the product. Knowledge of this value for a particular juice is needed if one is to make a sound determination of equipment needs for a plant, because both equipment and operating costs tend to increase with the degree of vacuum required. Hence, equipment designed to operate at a temperature safely, but not excessively, below such a critical point should operate with an appreciable saving.

Heat-induced changes in flavor during concentration are the result of both the temperature to which a juice has been heated and the length of time it is held at a particular temperature. Hence, there is more than one combination of time and temperature that will produce an equal degree of heat-induced off-flavor. The experiments reported in this paper were designed to meet the requirements of the apple processor who produces 75° Brix apple sirup by batchwise concentration in vacuum equipment and wishes to make apple juice concentrate for beverage purposes. Under these conditions the temperature factor becomes the important variable, because the time factor automatically becomes limited to that required by a batchwise cycle, which averages several hours. In a case where the residence time at a given temperature can be shortened considerably by some means, a higher temperature can be used. Examples of such relatively short residence times are found in the continuous equipment used for citrus juice concentration and in single-pass evaporators. With the latter type of evaporators, residence time may be only a few seconds.

Information has been published recently concerning methods for the preparation of apple-juice concentrates by concentration *in vacuo (2, 6)*. In addition, suggested plans are available for commercial use of the vacuum process *(1, 3)*, and results of storage tests over the period of one year on 4-fold concentrates have been published *(4)*. It has been reported *(6)* that the flavor of a blend of Western Delicious and Winesap apple juices (35% to 70%, respectively) is not significantly changed by concentration to 70° Brix at an absolute pressure of 4.5 inches of mercury. However, published information concerning the maximum allowable pressure during concentration in conventional vacuum con-

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**TABLE 1**

**Organoleptic evaluation of unconcentrated apple juice and of reconstituted concentrates prepared at various temperatures of evaporation**

| Variety | Soluble solids in juice (° Brix) | Freedom from off-flavor [b] | | | Fullness of natural flavor [c] | | |
|---|---|---|---|---|---|---|---|
| | | Untreated | 4.5" Hg.[d] | 6.7" Hg. | Untreated | 4.5" Hg. | 6.7" Hg. |
| Winesap | 13.0 | 8.7 | 8.4 | 6.9[e] | 8.5 | 8.0 | 7.1[e] |
| Rome Beauty | 10.1 | 8.8 | 8.5 | 7.4[e] | 8.6 | 8.4 | 7.7[e] |
| Standard Delicious | 12.7 | 8.5 | 8.7 | 7.7[e] | 8.4 | 8.4 | 7.7[e] |
| Gravenstein | 14.0 | 8.7 | 8.4 | 7.0[e] | 8.6 | 8.8 | 7.6[e] |
| Jonathan | 12.6 | 8.7 | 8.3 | 7.7[e] | 8.6 | 8.3 | 8.1 |

[b] Score of 10: no off-flavor.
[c] Score of 10: full natural flavor.
[d] All pressures are listed as absolute.
[e] Significant difference at P = 0.01.

centrating equipment does not appear to be sufficiently complete to serve as a guide to prospective processors.

This paper reports results of recent work which indicate that the same pressure limit is applicable to juices obtained from 5 common Western varieties (Winesap, Rome Beauty, Standard Delicious, Gravenstein, and Jonathan).

In conformity with commercial practice, pressures used during concentration rather than temperatures within the system are referred to in order to avoid unnecessarily complicated terminology. Flavor changes occurring during concentration are, of course, due to the temperature within the system. But as the temperature of the product rises during concentration at constant pressure, the latter serves as a simpler index for both discussion and practical application. The temperature rise during concentration of apple juice to 6-fold by volume averages about 6° F.

## METHODS

The general method used for determining the maximum pressure allowable during concentration of a juice consists of concentrating portions of a quantity of juice at various constant pressures, recombining the 3 fractions obtained from each run (concentrate, distillate and "non-condensibles" trapped in dry ice-alcohol traps) and comparing the recombined products organoleptically with the original material. Any differences in flavor can then be ascribed directly to the temperature occurring during concentration at constant pressure.

Samples of enzyme-clarified juices were prepared as described previously *(6)*, either from Yakima Valley, Washington (Winesap, Delicious, Rome Beauty, and Jonathan) or from Sonoma County, California (Gravenstein) apples chosen from good, sound, processing-grade fruit. Concentration was carried out to 6-fold by volume, which is considerably further than is required for a 4-fold concentrate plus dilution allowance for essence return in order that the information obtained be applicable to both high-density apple juice concentrate *(2)* and apple concentrate prepared for jelly stock.

In each case, a portion of clarified juice was packed in sanitary-tye enameled cans (307 x 409), frozen, and stored at —30° F. (—34° C.) for use as control samples in subsequent taste-panel evaluations. The remainder was used to prepare 6-fold concentrates in a falling-film evaporator *(7)* at 2 different absolute pressures (4.5 to 6.7 inches of mercury, equivalent to boiling points of water of 130° and 145° F. or 54° and 63° C., respectively). Fractions obtained during concentration (concentrate, distillate, and the volatile materials condensed at dry-ice temperatures) were recombined, packed in similar cans, frozen and stored at —30° F. (—34° C.) for subsequent evaluation.

The temperature in the jacket of the evaporator was carefully controlled in order to reduce to a minimum possible effects of localized overheating upon either the initial flavor or storage properties of the product. Jacket temperatures were maintained at 40° F. (22.2° C.) above that of the boiling point of water at the particular pressure used so that the heat input, and hence the rate of evaporation, during various runs would approach a constant value. The time required to concentrate a batch was 2 hours ± 5 minutes at each of the pressures used. Volatile flavor constituents were not stripped from the juice prior to concentration, since this investigation was set up to study solely the changes occurring during concentration; and it did not appear desirable to allow possible losses of volatile materials or other variables to affect panel appraisals.

Organoleptic evaluations were made by a panel of 15 experienced judges. Original and recombined samples of a given variety were judged as a group, three replications being used. Samples were scored on an arbitrary scale of values from 10 to 1 on the basis of (a) freedom from off-flavor and (b) fullness of natural flavor. Analysis of variance was applied to the scoring results according to the procedures described by Snedecor *(5)*.

## RESULTS

The results obtained from appraisal of individual Winesap and Delicious juices confirmed results previously reported *(6)* on a 70-30 blend of these two juices (Table 1). In neither case did the panel find a significant difference between control and recombined samples which have been concentrated at 4.5 inches of mercury, and in both cases, samples concentrated at 6.7 inches of mercury were found to be distinguishable (P = 0.01) from both the original juice and that concentrated at the lower pressure.

Appraisal of Jonathan, Rome Beauty, and Gravenstein juices showed that each of these behaved similarly to the Winesap and Delicious juices; i.e., no significant difference was observed between the original juice and that prepared at 4.5 inches of mercury while a difference was found between the juice concentrated at 6.7 inches of mercury and both the control sample and that concentrated at the lower pressure. There was some evidence that the juice from the Jonathan variety is slightly less heat-sensitive than that from other varieties.

## DISCUSSION

Results of organoleptic evaluations showed that a 6-fold concentrate (60-70° Brix, depending upon the soluble-solids concentration in the starting juice) can be prepared in the laboratory from each of these varieties at absolute pressures as great as 4.5 inches of mercury (equivalent to a boiling point of water of 130° F. or 54° C.) without causing a significant change of flavor.

Such evidence, obtained in laboratory equipment and with careful control, normally is not applied to commercial operations without careful consideration of the factors involved. One important consideration, equipment-wise, is the danger of localized overheating during evaporation. Use of a forced-circulation evaporator, or a similarly effective device in preference to jacketed or internal calandria types of evaporators, has been recommended *(3)* as lessening the possibility of such localized overheating. Another is that a factor of safety, temperature-wise, is desirable. It seems advisable that an absolute pressure not exceeding 4 inches of mercury (equivalent to a boiling point of water of 125° F. or

52° C.) be used for batchwise concentration of apple juice for beverage purposes.

The suitability of concentration at 4 inches of mercury, with regard to changes in flavors during concentration, has been substantiated by runs in semi-commercial equipment in the pilot plant of this laboratory. Over the past 2 years, relatively large amounts of juice (up to 1800 pounds per run) of each of these varieties have been concentrated in the pilot plant to as high as 70° Brix. In no case has a change in flavor been noted as a result of concentration at this pressure.

LITERATURE CITED

1. Eskew, R. K., Phillips, G. W. McP., Homiller, R. P., Redfield, C. S., and Davis, R. A. Frozen concentrated apple juice. *Ind. Eng. Chem.*, **43**, 2397 (1951).
2. Eskew, R. K., Redfield, C. S., and Phillips, G. W. McP. High-density, full-flavored apple juice concentrate. U. S. Dept. Agr. *AIC-315* (August 1, 1951).
3. Kaufman, V. F., Nimmo, C. C., and Walker, L. H. Frozen apple juice concentrate—application of laboratory data to prospective commercial operations. U. S. Dept. Agr. *AIC-293* (November, 1950).
4. Nimmo, C. C., Walker, L. H., and Seamans, V. S. Influence of storage conditions on frozen and canned apple juice concentrates. *Food Technol.*, **6**, 31 (1952).
5. Snedecor, G. W. *Statistical Methods.* Fourth ed., 1946. Iowa State College Press, Ames, Iowa.
6. Walker, L. H., Nimmo, C. C., and Patterson, D. C. Preparation of a frozen apple juice concentrate. *Food Technol.*, **5**, 148 (1951).
7. Walker, L. H., and Patterson, D. C. Experimental falling film evaporator for preparation of juice and purée concentrates at low temperature. *Ind. Eng. Chem.*, **43**, 534 (1951).

# Leach Pressing of Apples: A Method of Increasing the Yield of Full-Flavor Juice Concentrate[a]

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**An improvement in the manufacture of apple juice concentrate is presented. This method, "leach pressing" of the apples, gives 12 to 18 percent greater yield of concentrate per ton of apples than the conventional method of pressing. The apples are first pressed as usual. Then the cakes of pomace are broken up, cold water of approximately equal weight is added, and the mass again pressed. When this is done promptly no undesirable flavor is imparted to the concentrate made from the mixed juice. The water added is, of course, removed in evaporating the juice to make concentrate; therefore, no dilution of the final product is caused. Experimental runs were made using three different amounts of added water. For each of the three, yield figures were obtained and full-flavor high-density concentrates made, with essence returned to it. The concentrates were of as good flavor as concentrate made from the same apples using conventional single pressing. The value of the pomace as a source of pectin is not impaired. Although the costs of evaporation are obviously increased, this is more than offset by the increase in yield, with the result that the net financial return is appreciably greater. Complete commercial cost estimates of making concentrate at each of the three dilutions were made; these showed that a moderate dilution gave the best economic return.**

By the conventional method of pressing apples only about 80% of the juice is extracted, leaving in the pomace one-fifth of the juice value of the apples used. Some of this residual juice can be recovered by a second pressing, and obviously considerably more if water is first mixed with the pomace. Commercially there have been two objections to this; the second juice will have an "oxidized" flavor if the pomace is long exposed to air, and the added water dilutes the juice. The United States Standards for Grades of Canned Apple Juice, issued by the Production and Marketing Administration, exclude the juice of a second pressing. This is for single strength apple juice. No U. S. Standards exist for apple juice concentrate. Careful and rapid work can avoid deterioration of flavor, and if the juice is used to make concentrate the added water is removed.

One of the processing problems then is to avoid or minimize both fermentative and oxidative alteration of the character of the second-pressed juice. In the present work the attack was by shortening the time of exposure of the pomace to air. Another possibility, not yet investigated, is the use of an inhibiting agent in the water added to the pomace.

The costs of evaporation and processing are obviously increased by adding water, but this is more than offset by the increase in yield. This paper describes pilot-plant investigations at the Eastern Regional Research Laboratory of the United States Department of Agriculture, in which excellent full-flavor concentrated apple juice was made by this method. By "full flavor" is meant a concentrate to which there has been returned essence recovered from the juice before evaporation, thus restoring the volatile constituents which would otherwise be lost in the evaporation. Experimental runs with 3 different amounts of added water were made, yields were determined, and costs of equipment and of operation were calculated, to ascertain the most economical

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amount of water. With this amount of water, the quantity of concentrate produced per ton of apples is 16% greater than before. If apples cost $20.00 a ton, leach-pressing reduces the total cost of finished high-density concentrate (68.5° Brix), including all fixed charges, by nearly one cent per 6-ounce can.

It is well known that if the cakes of pomace from conventional pressing are broken up and then repressed, more juice will be pressed out. The additional amount obtained is, with good pressing, about 9% as much as the first-pressed juice *(1)*. If the presses give inadequate pressure, the once-pressed pomace will retain an unduly large amount of juice, and the juice from the second pressing may be as much as 13% of the first pressing *(6)*. Addition of water to pomace has been sometimes done in commercial operations where the resulting dilution of the juice can be tolerated, for instance, in making vinegar from apple juices of high sugar content, or in the manufacture of weak fermented cider such as the French "boisson de pomme" *(2)*. In neither of these cases is it necessary to guard against the oxidized or fermented flavor that the juice will acquire if the pomace is let stand long between pressings. In fact, Warcollier *(2)* recommends letting the wetted pomace soak 6 to 12 hours, although fermentation, he says, starts quickly when pomace is taken out of the press. In the manufacture of fermented cider of the English type, this has been considered to improve the flavor of the final product *(1)*, but in our case long standing of the pomace would alter the characteristic fresh apple flavor which the concentrate is designed to possess.

## EXPERIMENTAL PROCEDURE

The investigations were made on pilot-plant scale. The apples were a mixture of 2 parts Jonathan, 1 part Stayman Winesap, 1 part McIntosh and 1 part Northern Spy. They were of "peeler" and "juice" grades, and had been 2 months in storage at 35-40° F. A conventional cider press was used. The hammer mill had serrated hammers, 22" swing diameter, 2300 RPM, and a 9/16" screen. The hydraulic ram gave 110-120 p.s.i. pressure on the cheeses; although not extremely high, this is in the range of modern practice. Maximum pressure was reached in 7 minutes, and held for 10 minutes, which gave pomace of 74-75% moisture. Preliminary studies had shown that only 0.8% more juice would be obtained by holding the pressure for 10 minutes additional, and another 0.5% in a third 10-minute period, and in any case such long pressing times are commercially undesirable. The juice was 12.5° Brix.

The cakes of pomace from the first pressing were moderately disintegrated by a machine similar to a hammer mill run at very slow speed (450 r.p.m.), but equipped with sharp knives and a screen having 1" holes. In a tank, water was then thoroughly mixed into the pomace. To determine optimum conditions, various weights of added water were used in the different experiments, ranging from 75% to 150% of the weight of the pomace from the first press, or about 16% to 32% of the weight of the apples. These amounts of water were completely absorbed by the pomace, leaving it unchanged in appearance though somewhat softer and with more tendency to compact by pressure. The moistened pomace was re-pressed in the same manner as before. This juice, when added to the first pressed juice, gave a mixed juice which was 11.3° Brix for the 75% water addition, 10.7° Brix for the 100%, and 10.0° Brix for the 150%.

Table 1 shows typical yield figures calculated from the average results of the runs made at 3 different ratios of water to pomace. The "sugar extraction" figures are expressed as pounds of sugar in the juice obtained per 100 pounds of sugar in the apples. These figures are of course in direct proportion to the amount of concentrated juice that can be made from a given quantity of apples. Thus, another way of expressing the increase in yield—in the third column, for example—is to say that for every 81.5 cans of concentrate that would be obtained by the conventional single pressing, the use of this leach-pressing system would give 14.5 cans more, or an increase of nearly 18% in the total amount. Obviously the use of still greater quantities of water would give slightly higher yields; not much higher, for the yield shown is already 96% of complete extraction. As will be discussed later, the cost of processing such greater quantities of water would be an important item. Moreover, if as much as 1.75 times the weight of the pomace is used, it is not completely absorbed by the pomace, and some dripping occurs. In commercial practice this would complicate the design of the conveyors and introduce problems of sanitation.

**TABLE 1**
**Extraction efficiencies of pressing**

| Water added, ratio to pomace | 0.75 | 1.00 | 1.50 |
|---|---|---|---|
| Sugar extraction, % | | | |
| First pressing | 81.5 | 81.5 | 81.5 |
| Second pressing (with water) | 10.8 | 13.3 | 14.5 |
| Total | 92.3 | 94.8 | 96.0 |

If the apples have been ground by a hammer mill, holding the moistened pomace for a long time before pressing will not increase the yield appreciably. With an average elapsed time of 15 minutes between adding the water and starting the second pressing, the sugar will become nearly completely equalized (by mixing and diffusion) between the pomace and the added water by the time the juice starts to run out of the press. Calculations of efficiency of the extraction obtained, based on weights and analyses of the pomace for sugar and for moisture, confirm this. With the equipment used it was not possible to investigate the adequacy of shorter times.

The value of the pomace as a commercial source of pectin is not impaired by this procedure. Analytical determinations of the pectin grade of the final pomace showed it to be at least as good as the pomace from the first pressing. Furthermore, the removal of sugar from the dried pectin, a step preliminary to the extraction of pectin, should be facilitated because there is less sugar to remove.

**Quality of product.** A full-flavor concentrate (68.5° Brix) was made from the combined juices of the first and second pressings, and another was made from juice that had been obtained by conventional single pressing from the same blend of apples. When diluted to drinking strength (12.5° Brix) by adding 6 volumes of water, taste tests showed that the product containing the second pressed juice had the flavor of a high-grade apple juice. It was equal in quality to the single pressed product, with a slightly different flavor which some tasters preferred.

Storage tests of the above concentrates were made at 35° F. After eight months in storage, the taste tests showed the concentrate made from the combined juice of first and second pressings to be practically equal in quality to that made from conventional juice.

## EQUIPMENT SUGGESTED FOR COMMERCIAL OPERATION

No detailed recommendations for equipment for commercial operation are here made. However, the following discussion will give a prospective processor an idea as to the equipment that would be required.

The equipment needed, in addition to that required for a plant to make concentrate from apples by single pressing, includes a pomace disintegrator, a cider press, a conveyor from picker to press, provision for adding water and thoroughly mixing it into the pomace, and increased capacity in all equipment converting juice into concentrate. Table 2 shows the increase in capacity required for each department, given as a percentage of that required for single pressing. This is given for 3 typical ratios of water to pomace, 0.75, 1.00 and 1.50.

Hammer mills are used on the apple presses. No tests were made on apples ground by a grater, because it was felt that a

**TABLE 2**
**Increase in equipment requirements for leach pressing (Percent of capacity for single pressing)**

| Water added, % on pomace | 75 | 100 | 150 |
|---|---|---|---|
| Cider pressing equipment | 50 | 50 | 50 |
| Juice-handling equipment | 25 | 36 | 49 |
| Evaporating equipment | 29 | 42 | 59 |
| Concentrate-handling equipment | 13 | 16 | 18 |

hammer mill would mash the apple tissue more completely and so enable more rapid and complete diffusion of the juice into the added water.

The pomace from the first presses should be well broken up, free from large lumps. For this purpose a suitable machine is one similar to a hammer mill but having sharp knives, equipped with a screen with 1" holes and run at 400-500 r.p.m. Water must now be added to the pomace, and the moistened pomace conveyed to the second press, being held a short time on the way. Fifteen minutes holding, including the time to load the second press, is adequate; it is possible that a shorter time may suffice. The moistened pomace is still firm in consistency, not soupy, though liable to agglomerate if squeezed; therefore, a drag conveyor (i.e. a flat trough with scrapers) is most suitable. The mixer for holding the moistened pomace over the second press can well be a trough of large diameter, with a ribbon screw. The cloths can be loaded from a chute on the bottom of this mixer. For a plant having 2 apple presses, a third one of the same size is adequate for the second pressing of the pomace from both.

The juices from first and second pressing are combined and processed to form full-flavor concentrated apple juice, either high-density (7-fold) or frozen (4-fold). The process and commercial equipment for making the 7-fold concentrate have been described by Eskew, Phillips and Redfield *(3)*. This publication also gives estimated costs of equipment and of production. Similar information for the frozen concentrate has been published by Eskew, Phillips, Homiller, Redfield and Davis *(4)*. Information on making frozen concentrate has also been given by Kaufman, Nimmo and Walker *(5)* and by Walker, Nimmo and Patterson *(7)*.

## COSTS

In order to determine the reduction in cost of producing concentrate by leach pressing, and to discover what amount of added water gives the greatest economic return, complete cost calculations have been made for each of the 3 water ratios considered. The size of plant chosen will process 42 tons of apples per day. This is considered to be an average for moderate size apple juice plants. The product is full-flavor high-density (7-fold) concentrate of 68.5° Brix, packed in 6-ounce cans.[e]

Table 3 shows the estimated total costs of producing concentrate in the several plants, including 5% interest on investment and 10% depreciation. Such incidental items as supplies, taxes and insurance are included. The plant is assumed to operate 75 days a year, 16 hours a day. Apples are assumed to cost $20.00 a ton. The detailed costs given in the table are expressed as dollars per day. It will be seen that a plant using single pressing would produce only 20,400 6-ounce cans of concentrate per day, whereas the leach pressing plants produce 23,000 to 24,000 according to the amount of water added.

[e] Including an allowance of 13% for unforeseen contingencies, also 20% for engineering fees, the total cost of such a plant for single pressing would be $267,000. For leach pressing, using water equal to 75% of the weight of the pomace, it would be $301,000; for water equal to the pomace weight, $311,000; for water 150% of the pomace weight, $326,000. To these figures is then added 21% for working capital.

**TABLE 3**
**Cost of producing concentrate from 42 tons apples/day, 75 days/year (dollars per day)**

| Water added, % on pomace | None | 75 | 100 | 150 |
|---|---|---|---|---|
| Apples | $ 840 | $ 840 | $ 840 | $ 840 |
| Labor and salaries | 577 | 596 | 598 | 601 |
| Cans, supplies, power, etc. | 585 | 669 | 695 | 717 |
| Maintenance and repairs | 137 | 169 | 172 | 177 |
| Interest, depreciation, taxes, etc. | 672 | 754 | 778 | 814 |
| Total cost per day | $2,831 | $3,048 | $3,083 | $3,149 |
| Output: 6-oz. cans/day | 20,400 | 23,070 | 23,720 | 24,030 |
| Total cost/can, cents | 13.88¢ | 13.13¢ | 13.00¢ | 13.10¢ |

## CONCLUSIONS

The last line of the table gives the final conclusions reached by applying cost calculations to the experimental results; namely, that leach pressing will reduce the cost of producing 7-fold concentrate by nine-tenths of a cent per can, and that the addition of water equal to the weight of the pomace gives the least total cost—less than the use of either more water or less water. Different assumptions than here made will, of course, shift all these figures somewhat. Higher priced apples would increase the saving, and increase the optimum amount of water addition. So also would a longer operating season, because the additional investment would have longer to "earn its keep." But all in all, the average expectation is that, by leach pressing, the total cost per can of concentrate can be reduced by 6 or 7%, and that 16% more cans can be made from a given crop of apples. And this can be accomplished without injuring the flavor of the product.

## LITERATURE CITED


1. Charley, V. L. S., and Kieser, M. E. *Annual Report, Long Ashton Research Station*, 1940, pp. 89-96.
2. Charley, V. L. S. *The Principles and Practice of Cider-Making*. 1949, Leonard Hill, Ltd., London, 90-94; translated from Warcollier, G., *La Cidrerie*, 3d Ed., 1928, J.-B. Baillière et Fils, Paris.
3. Eskew, R. K., Redfield, C. S., and Phillips, G. W. Macpherson. U. S. Dept. Agr., Bur. Agr. Ind. Chem., Eastern Regional Research Laboratory, *AIC-315* (1951).
4. Eskew, Roderick K., Phillips, G. W. Macpherson, Homiller, Richard P., Redfield, Clifford S., and Davis, Rudolph A. *Ind. Eng. Chem.*, **43**, 2397-2403 (1951).
5. Kaufman, Vern F., Nimmo, C. C., and Walker, L. H. U. S. Dept. Agr., Bur. Agr. Ind. Chem., Western Regional Research Laboratory, *AIC-293* (1950).
6. Smock, R. M., and Neubert, A. M. *Apples and Apple Products*. 1950, Interscience Publishers, Inc., New York, 327.
7. Walker, L. H., Nimmo, C. C., and Patterson, D. C. *Food Technol.*, **5**, 148-151 (1951).

# Observations on Methods to Determine Food Palatability and Comparative Freezing Quality of Certain New Strawberry Varieties

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**The texture, color, and flavor of the quick-frozen fruits of four strawberry seedlings were evaluated by sensory methods. Results indicated that two varieties, Monmouth and Maine 55, could be recommended for freezing preservation. Added low methoxyl pectin (0.15%) had no detectable effect on the texture, color, or flavor of the frozen berries. With regard to measuring palatability, correlations of duplicate ranking tests did not accurately predict the judges who found significant differences among samples.**

Strawberries are a minor crop in the State of Maine. *The Census of Agriculture* for 1950 *(9)* reports only 393 acres in 1949 excluding home-garden production, for which data are unavailable. The rapid growth of the quick-freeze industry provides a potential outlet for greatly increased strawberry acreage. Freezing obviates commercial losses from shipping fresh berries to distant markets and facilitates the preservation of home-garden surplus.

Howard 17 (Premier) has been and is the most popular strawberry variety grown in Maine. Its extreme susceptibility to red stele disease *(Phytophthora fragariae)*, seriously prevalent in the State, and its inferior quality after quick freezing warranted a breeding project directed toward the development of disease-resistant varieties, adaptable to the rigorous climate of Maine and superior in frozen quality. In 1952, 3 varieties resulting from this study were released for evaluation by Maine growers *(1)*. These showed high resistance to red stele disease. The plants in trial plots in Aroostook County were winter hardy and the yields resistance further reduction was effected by means of taste tests. In these preliminary tests, soft texture seemed to be associated with the low-ranking (inferior) seedlings. In a final appraisal of 4 desirable seedlings, a treatment of pectin was superimposed on variety to compared favorably with standard varieties *(1)*.

The methods and results of tests to determine the relative palatability of these strawberry seedlings after quick-frozen storage are described in this paper. Texture, flavor, and color were considered the important characters of palatability requiring evaluation. After a survey of methods for testing food quality, a ranking technique *(2, 4)* was adopted as most suitable to obtain the information desired. This technique has been developed to indicate the acceptability of foods and may be used with untrained observers, thereby eliminating the bias of preconceived flavor standards.

After the number of seedlings was greatly reduced on the basis of yield, plant vigor, hardiness, and disease test by sensory methods the firming action of pectin as well as relative varietal quality. Pectin treatment was reported *(5)* as successfully improving the texture of soft Tennessee Supreme strawberries.

## METHOD

**Freezing.** The strawberries, all grown under similar cultural treatment, were processed within 2 hours of morning harvest. Berries of similar maturity and size were selected for processing insofar as possible, although some varieties characteristically bear larger berries than others. Day-to-day weather effects could not be completely eliminated because of varietal differences in ripening dates but all of the berries were harvested and processed during a period of 8 days.

Sliced berries (3 parts berries to one part 60% syrup by weight) were quick-frozen in a home-type freezer at —20° F. Comparable samples were packed with syrup containing 0.15% (based on berry weight) low-methoxyl pectin de-esterified by an alkaline medium. This was the maximum amount recommended to avoid visible gel clumps in the thawed berries *(6)*. The berries were stored for 10 months at 0° F.

**Palatability.** Although a ranking technique *(2, 4)* was used to determine frozen berry quality, 10 judges also evaluated the samples by a scoring method for purposes of comparison.

Six varieties, with and without pectin, were tested: 4 seedlings, Howard 17, and Sparkle, a variety highly recommended for freezing *(7)*. Since no statistical design has been devised for testing 12 items, a commercially processed sample was added to the study. This was purchased in one 30-pound container and appeared to be homogeneous. The texture of these berries was almost a puree but nothing better was available in large packs.

**Design.** The berries were presented to 28 judges 13 times in blocks of 4 at a time, according to a balanced incomplete block design *(3)*. Two blocks were judged at each session with a 10- to 15-minute interval between blocks. The code numbers and the order of presentation were randomized.

The berries, thawed to room temperature, were served in white glazed evaporating dishes under white fluorescent light.

The judges were instructed to rank the 4 samples in order of preference for flavor and for color and in order of firmness for texture.

**Judges.** All 28 judges who completed the 13 tests had had experience judging strawberries or other foods.

To test the reliability of the judges prior to the experiment, 23 of the 28 judges ranked duplicate or triplicate sets of four frozen strawberry samples of known or reputed differences in flavor and texture *(2)*. Ranks were transformed to scores and correlation coefficients of +.54 or above were shown by 12 judges for texture and by 16 judges for flavor.

No one was excluded from the study on the basis of these tests but all persons continued to judge during the experiment. At the end of the study, the scores of each judge were analyzed by variance.

A comparison of the correlations from the preliminary duplicate tests and each judge's final significance level in the experiment (Table 1) showed that one of 12 and 5 of 16 judges with r's of +.54 or better did not discriminate significantly among the unknown samples in texture and flavor respectively. Conversely, 6 of 11 and 3 of 7 judges, who would have been eliminated from judging on the basis of preliminary duplicate tests actually found significant differences in texture and flavor. Thus, the duplicate tests were not sufficiently diagnostic to permit selection of judges without additional replications.

Limited sample material and time on the part of volunteer judges precluded an intensive study of the number of replications needed to predict judge acuity.

It has been the practice here to welcome any interested individual as a judge, insofar as sample material is available, and to segregate the discerning judges by variance analyses of individual scores. By this method, 45 to 69% of volunteer judges (13 to 29) have been discerning at the 10% level or better in flavor judgment of many foods tested. An additional objection to pretesting judges for diagnostic purposes is the difficulty in choosing samples when the differences are unknown to the investigator and to know what degree of difference should be detected by a potential judge.

**TABLE 1**

**Comparison of the correlation coefficients from duplicate preliminary tests with the final judge significance (variance) for the experiment by 23 judges**

| Quality tested | Duplicate tests Total number of judges: | Significance levels in experiment Number of judges at: | | | |
|---|---|---|---|---|---|
| | | 1% | 5% | 10% | N.S.[a] |
| | with r +.54 or above | | | | |
| Texture | 12 | 9 | 1 | 1 | 1 |
| Flavor | 16 | 1 | 6 | 4 | 5 |
| | with r below +.54 | | | | |
| Texture | 11 | 3 | 3 | 0 | 5 |
| Flavor | 7 | 2 | 0 | 1 | 4 |

[a] N.S. = no significance.

## RESULTS

Each quality was evaluated by means of separate variance analyses according to judge significance in order to compare the linear arrangement of varieties as judged only by significant tasters versus all tasters. It is obvious that only discerning judges would reject or accept a product on the basis of sensory quality. If a consistent trend, short of significance, is shown by many individuals however, a final alignment with significant differences may be established. This might indicate differences so slight as to be inconsequential or real differences which could be detected by more acute judges.

**Texture.** For texture, the linear arrangement of samples by all 27 judges was practically the same as by the 20 significant judges (Table 2). The significant judges rated Monmouth, no pectin, better than the average of the succeeding group of varieties, while Orland was rated poorer in texture than any of the other trial varieties.

**Color.** All but one of the 28 judges found significant color differences (Table 3). The color of the 2 Monmouth samples was preferred to that of Sparkle. Sparkle was considered better

**TABLE 2**

**Texture of strawberries, frozen with and without pectin**

| Comparison of ratings by all and by significant (5% level) judges | | | | | |
|---|---|---|---|---|---|
| Samples[b] | | Scores of Significant 20 judges | Samples | | Scores all judges[c] |
| Monmouth | 0[d] | +36.17 | Monmouth | 0 | + 41.36 |
| Maine 55 | 0 | +33.09 | Maine 55 | 0 | + 39.87 |
| Monmouth | + | +32.44 | Monmouth | + | + 38.49 |
| Maine 54 | + | +29.78 | Maine 54 | + | + 38.49 |
| Maine 55 | + | +23.26 | Maine 54 | 0 | + 24.20 |
| Maine 54 | 0 | +21.67 | Maine 55 | + | + 23.39 |
| Sparkle | + | +13.30 | Sparkle | + | + 15.36 |
| Sparkle | 0 | + 2.66 | Sparkle | 0 | + 6.31 |
| Howard 17 | 0 | −10.68 | Howard 17 | 0 | − 10.08 |
| Howard 17 | + | −13.68 | Howard 17 | + | − 15.35 |
| Orland | + | −38.75 | Orland | + | − 47.72 |
| Orland | 0 | −47.59 | Orland | 0 | − 52.05 |
| Commercial | | −81.67 | Commercial | | −102.27 |
| F | | 38.83** | | | 32.05** |
| L.S.D. 5% | | 17.66 | | | 21.74 |
| 1% | | 23.29 | | | 28.64 |

[b] Group divisions indicate differences at the 5% level or better when the scores were compared by Tukey's method *(8)*.

[c] Twenty-seven judges: 20 at 5%, 1 at 10%, and 6 not significant.

[d] 0 = no pectin; + = 0.15% pectin based on berry weight.

**TABLE 3**

**Color of strawberries, frozen with and without pectin**

| Samples[a] | | Scores of all judges |
|---|---|---|
| Monmouth | + | + 79.64 |
| Monmouth | 0 | + 69.08 |
| Sparkle | + | + 50.77 |
| Sparkle | 0 | + 40.68 |
| Maine 55 | 0 | + 12.49 |
| Maine 54 | 0 | + 9.78 |
| Howard 17 | 0 | + 9.75 |
| Maine 54 | + | + 6.78 |
| Maine 55 | + | − 8.79 |
| Howard 17 | + | − 13.38 |
| Orland | + | − 75.23 |
| Orland | 0 | − 75.31 |
| Commercial | | −106.26 |
| F | | 62.4** |
| L.S.D. 5% | | 19.99 |
| 1% | | 26.34 |

[a] Group divisions indicate differences at the 5% level or better when the scores were compared by Tukey's method *(8)*.

colored than Maine 55, Maine 54, and Howard 17, while Orland was rated poorest.

**Flavor.** The linear arrangement of the samples was approximately similar irrespective of judge significance (Table 4). When sample comparisons were based on the 16-judge records, 3 significantly different groups resulted whereas only 2 emerged from an analysis of the 11-judge records. It will be noted, however, that the values differed only between groups rather than between adjacent scores.

A comparison of the records of 20 men and 8 women showed no significant differences associated with sex for any of the qualities studied.

**Effect of added pectin.** It is obvious (Tables 2-4) that the addition of pectin did not detectably affect the quality of the berries.

The lack of differential response to pectin-treated and untreated strawberries was not in agreement with the results of other investigators *(5, 6)*, who reported improved texture and color with added pectin. The amount used in this study (0.15% of berry weight) was the maximum recommended by Joseph *(6)* although Grab *et al. (5)* suggested 0.20 to 0.30% as the optimum concentration. It is quite possible that variety, locality, and growing conditions influence the pectin requirement for a detectable firming effect. The syrup from pectin-treated berries was noticeably more viscous at low temperatures. When 7 to 9 pairs of comparable thawed (to 14° C.) samples of each variety were drained on an 8-inch, 8-mesh sieve for 2 minutes, the percent of total weight drained as juice from pectin-treated berries averaged 10% less than that drained from untreated berries (Figure 1).

**Variety evaluation.** As no effect of pectin was noted by sensory methods, the varieties were appraised (Table 5), disre-

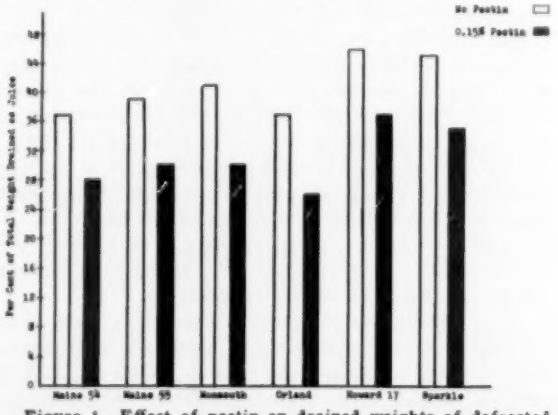


**Figure 1. Effect of pectin on drained weights of defrosted strawberries (3 + 1 in 60% syrup).**

**TABLE 4**

**Flavor of strawberries, frozen with and without pectin**
**Comparison of all vs. significant judges**

| Samples[a] | Scores of significant (5%) 11 judges | Samples[a] | Scores of significant (10%) 16 judges | Samples[a] | Scores of all judges[c] |
|---|---|---|---|---|---|
| Sparkle + | +32.23 | Sparkle + | +43.13 | Sparkle + | +56.35 |
| Sparkle 0 | +23.86 | Sparkle 0 | +30.64 | Sparkle 0 | +34.76 |
| Monmouth 0 | +11.63 | Monmouth 0 | +16.35 | Monmouth 0 | +24.72 |
| Maine 55 + | + 9.57 | Maine 55 + | +11.63 | Maine 55 + | +18.67 |
| Maine 55 0 | + 7.12 | Maine 55 0 | + 9.31 | Maine 55 0 | +17.03 |
| Maine 54 0 | − 2.19 | Monmouth + | − .26 | Monmouth + | + .94 |
| Monmouth + | − 2.19 | Orland 0 | − 4.25 | Orland 0 | − 1.59 |
| Orland + | − 8.58 | Maine 54 0 | − 7.77 | Maine 54 0 | −11.89 |
| Orland 0 | − 9.10 | Orland + | −12.70 | Maine 54 + | −23.86 |
| Maine 54 + | −12.23 | Maine 54 + | −14.89 | Orland + | −23.94 |
| Howard 17 0 | −12.23 | Howard 17 + | −20.81 | Howard 17 + | −26.00 |
| Howard 17 + | −17.29 | Howard 17 0 | −23.00 | Howard 17 0 | −31.24 |
| Commercial | −20.60 | Commercial | −27.38 | Commercial | −33.95 |
| F | 7.00** | F | 9.06** | F | 9.57** |
| L.S.D. 5% | 16.97 | L.S.D. 5% | 19.80 | L.S.D. 5% | 25.60 |
| 1% | 22.46 | 1% | 26.14 | 1% | 33.73 |

[a] Group divisions indicate differences at the 5% level or better when the scores were compared by Tukey's method *(8)*.
[c] Twenty-eight judges: 11 at 5%, 5 at 10%, and 12 not significant.

**TABLE 5**

**Texture, flavor, and color of strawberry varieties after frozen preservation**

| Texture | | Flavor | | Color | |
|---|---|---|---|---|---|
| Variety[b] | Score[i] 21 judges | Variety[b] | Score[i] 16 judges | Variety[b] | Score[i] 28 judges |
| Monmouth | +71.27 | Sparkle | +73.77 | Monmouth | +148.72 |
| Maine 55 | +59.74 | Maine 55 | +20.94 | Sparkle | + 91.45 |
| Maine 54 | +54.84 | Monmouth | +16.09 | Maine 54 | + 16.56 |
| Sparkle | +16.69 | Orland | −16.95 | Maine 55 | + 3.70 |
| Howard 17 | −26.42 | Maine 54 | −22.66 | Howard 17 | − 3.63 |
| Orland | −90.33 | Howard 17 | −43.81 | Orland | −150.54 |
| F | 48.72** | F | 17.39** | F | 99.98** |
| L.S.D. 5% | 24.99 | L.S.D. 5% | 28.02 | L.S.D. 5% | 21.26 |
| 1% | 32.55 | 1% | 37.00 | 1% | 37.24 |

[b] Group divisions indicate differences at the 5% level or better when the scores were compared by Tukey's method *(8)*.
[i] The scores do not total zero because the commercial variety, having no pectin treatment, was not considered in the analysis.

garding treatment, using only the records of discriminating judges (10% level or better). At least 2 of the new varieties compared favorably with Sparkle. Three of them were superior in texture and one in color. All of the new varieties were inferior to Sparkle in flavor, but Maine 55 and Monmouth were superior to the others in this respect. Howard 17 and Orland were rated inferior in all 3 qualities and should not be recommended for freezing.

## COMPARISON OF SCORING AND RANKING METHODS TO JUDGE STRAWBERRY TEXTURE

Ten of the more experienced judges scored as well as ranked the samples for texture on the same day. The statistical design was the same for both methods but the orders of presentation were randomized separately. The judges scored the samples from 1, *very firm*, to 5, *very mushy*, and the commercial variety was submitted as a *very mushy*, 5, standard.

Variance analyses of the resulting data showed that each of the 10 judges detected significant differences by scoring while only 5 discriminated among the varieties by ranking. This suggests that a more critical test of judge perception results from ranking. It was noted in the scored tests that the total range of scores was seldom used. In only 3 of the 13 blocks were samples scored as *very firm*, probably because the usual connotation of the term *very firm* does not apply to frozen strawberries. Three of the judges used a score range of only 3 in a majority of the blocks, while one judge used only a 2 score range in 6 of the 13 blocks. Failure to use the entire range results in apparent judge consistency whether the scores are compared by correlation coefficients or analyzed by variance. Judge acceptance cannot be safely based on this criterion without special care to eliminate judges who do not use the entire range of scores.

Four significantly different groups of samples resulted from scoring while only 3 resulted from ranking (Table 6) by the same 10 judges. It is possible that misleading judge consistency, reflected in the small error variance by scoring, may have resulted in deceptively significant treatment differences. The linear arrangement of samples was quite similar by both techniques.

The ranking mehtod seemed preferable for judging relative strawberry firmness, especially when a known desirable variety, such as Sparkle, was included among the samples as a point of reference.

## SUMMARY

The quick-frozen fruits of 4 strawberry seedlings were evaluated by sensory methods for texture, color, and flavor.

The quality of two of the seedlings compared favorably with Sparkle, as judged by the discerning tasters from a group of 28 judges. On the basis of the palatability tests, Monmouth and Maine 55 were deemed worth recommending for freezing preservation while

**TABLE 6**

**Texture of thawed frozen strawberries**
**Comparison of ranking and scoring methods by ten judges**

| Sample [1] | | Average scores of 10 judges [2] | Sample [3] | | Total scores from ranks of 10 judges [1] |
|---|---|---|---|---|---|
| Maine 54 | + | 2.18 | Maine 55 | 0 | +18.54 |
| Maine 54 | 0 | 2.22 | Monmouth | 0 | +13.77 |
| Monmouth | + | 2.30 | Monmouth | + | +13.56 |
| Maine 55 | + | 2.35 | Maine 54 | 0 | +11.24 |
| | | | Maine 54 | + | +10.30 |
| Maine 55 | 0 | 2.60 | Maine 55 | + | + 6.91 |
| Monmouth | 0 | 2.70 | Howard 17 | + | + 3.65 |
| Howard 17 | + | 2.82 | Howard 17 | 0 | − 1.07 |
| Sparkle | + | 3.02 | Sparkle | 0 | − 1.80 |
| Sparkle | 0 | 3.05 | Sparkle | + | − 2.06 |
| Howard 17 | 0 | 3.10 | | | |
| | | | Orland | 0 | −16.22 |
| Orland | 0 | 3.52 | Orland | + | −19.74 |
| Orland | + | 3.65 | | | |
| | | | Commercial | | −37.08 |
| Commercial | | 4.88 | | | |
| F | | 37.7** | | | 12.4** |
| L.S.D. | 5% | 0.35 | | | 12.7 |
| | 1% | 0.45 | | | 16.8 |

[1] Group divisions indicate differences at the 5% level or better when the scores were compared by Tukey's method *(8)*.
[2] All judges significant at the 5% level or better.
[3] Five judges significant at the 5% level or better.

Orland and Howard 17 were of inferior freezing quality.

The addition of 0.15% low methoxyl pectin to 60% syrup did not produce a detectable effect on the 3 measured characteristics of the frozen berries. The pectin decreased the percent of total weight drained as juice from the thawed berries by an average of 10%.

Observations on methods of measuring palatability indicated that correlations of duplicate ranking tests did not accurately predict the judges who found significant differences among samples.

A comparison of ranking and scoring methods for strawberry texture by 10 judges resulted in quite similar linear arrangements of samples. The appraisal of judges was less critical by scoring, probably because the entire range of scores was not used by all of the judges.

**Acknowledgments**

The writers are indebted to Dr. Lyle D. Calvin, Biometrician, G. D. Searle and Company, Chicago, for assistance in analyzing the data and to the many individuals who acted as judges.

LITERATURE CITED

1. Bailey, R. M., and Murphy, E. F. Orland, Monmouth, and Maine 55 Strawberries. Me. Agr. Expt. Sta. *Misc. Pub.* 620 (1952).
2. Bliss, C. I., Anderson, E. O., and Marland, R. E. A technique for testing consumer preferences, with special reference to the constituents of ice cream. Conn. (Storrs) Agr. Expt. Sta. *Bull. 251* (1943).
3. Cochran, W. G., and Cox, G. M. *Experimental Designs.* 1950, John Wiley and Sons, Inc., New York.
4. Dove, W. F. The relative nature of human preference: With an example in the palatability of different varieties of sweet corn. *J. Comp. Psych.*, **35**, 219-226 (1943).
5. Grab, E. G., Wegener, J. B., and Baer, B. H. Firming strawberries before freezing. *Food Packer.* November, 1948.
6. Joseph, G. H. Low methoxyl acid pectinates. 1947, California Fruit Growers Exchange, Products Dept., Ontario, Calif.
7. Robinson, W. B., Lee, F. A., Slate, G. L., and Pederson, C. S. Chemical composition and freezing adaptability of strawberries. N. Y. Agr. Expt. Sta. *Bull. 726* (1947).
8. Tukey, J. W. Comparing individual means in the analysis of variance. *Biometrics*, **5** (2) 99-114 (1949).
9. U. S. Bureau of Census. *Census of Agriculture, 1950:* New England States.

# Storage Changes in Processed Apple Sauce[a,b]

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**Chemical and physical changes taking place in applesauce prepared and stored under different conditions were studied. In particular, factors affecting the development of discoloration during storage were investigated in an effort to find means of controlling them. Storage temperature was found to be the governing factor in the gradual breakdown of carbohydrate constituents, while headspace oxygen appears to be an essential reactant in the formation of the localized "ring discoloration."**

Although the rapid effects of enzymatic or microbiological action are arrested during canning, further changes due to the interaction of the chemical constituents of processed food can and do occur. Degradative reactions, such as rancidity, oxidation, darkening or bleaching, and the accompanying losses in desirable flavor, odor, consistency, or nutritional characteristics are incurred primarily during storage. Generally these changes are slow, and the extent of their occurrence is affected by storage time and temperature, and frequently by the nature of the container.

Most of the investigations on storage changes in fruit and vegetable products have been confined to a consideration of certain reactions responsible for the development of discoloration. Less research has been undertaken to establish the nature of the over-all changes taking place in a product during storage. Although the present study was prompted by the desire to determine the cause of storage darkening in glass-packed applesauce, it was also undertaken to establish the nature of possible storage changes affecting a number of physical and chemical properties of the product.

## EXPERIMENTAL

Two packs of applesauce, prepared from apples grown in the orchards of the University of Massachusetts during the 1950 and 1951 seasons, were used in these experiments. The first pack, consisting of applesauce prepared from McIntosh apples, was

[a] Presented at the Thirteenth Annual Meeting of the IFT at Boston, Massachusetts, June 23, 1953.
[b] Contribution No. 903, Massachusetts Agricultural Experiment Station.

stored under different conditions with or without additives, and analyzed at monthly intervals for 11 months. The applesauce in the second pack was prepared from 6 varieties of Massachusetts apples, sufficiently different in their compositional characteristics to bring out the effect of selected properties, such as acidity, tannin content, or skin pigmentation, upon the storage behavior of the resulting product. This pack contained no additives, but the effect of using peeled apples on the discoloration of the applesauce was tested. The jars in this pack were examined for discoloration at 6-month intervals over a 1½-year period. All jars were stored in the dark.

**Preparation of applesauce.** The following procedure was used in the preparation of the applesauce: the apples were washed (peeled in some cases), trimmed and quartered, heated in a steam-jacketed kettle with one part of water to 4 parts of apples, passed through a Fitzpatrick comminutor[c] (15-mesh screen), deaerated in a vacuum pan (or by the passage of nitrogen gas), and filled hot into commercial type 4½ oz. baby food jars. The jars were then sealed by a steam flow type vacuum sealing machine and processed in a still retort for 20 minutes at 100° C. (212° F.).

**Measurement of discoloration.** A Photovolt Reflectometer,[d] Model 610, equipped with a tristimulus green filter, was used to measure the increase in darkness incurred by the applesauce. Munsell paper standards provided an exact and unchanging basis for the measurement. These were: 5YR 3/4 = 0% reflectance, and 10YR 8/5 = 100% reflectance. Readings obtained were converted to a white scale by the formula:

$$\% \text{ Reflectance} = 12 + \frac{(87 - 12)}{100} (\% \text{ observed reflectance})$$

Since the examination of commercial storage darkened applesauce in glass jars had shown the presence of both a "ring" or graded discoloration, and a "body" or diffused discoloration, reflectance readings were taken on the upper and lower portions of the applesauce. These measurements were then integrated into one value indicative of the total discoloration incurred. The following formula, previously discussed by Livingston and Vilece *(5)*, was used:

$$\text{D. I.} = 10(\text{E. R. D.} + \text{E. B. D.})$$

where

D. I. is the "Discoloration Index"

E. R. D. is the "Effective Ring Discoloration" defined as the difference in reflectance between bottom and top of jar contents, and

E. B. D. is the "Effective Body Discoloration" defined as the difference in reflectance between the sample at the start of the storage period and the bottom of the sample tested after storage.

It is pertinent to note that the removal of the applesauce from the jar was not found to be required for accurate reflectance measurement. In testing the second pack, therefore, the search unit of the reflectometer was held directly against the portion of the jar being measured, and the reflectance of the applesauce was determined through the glass.

**Preparation of applesauce filtrate.** To measure any color changes affecting the liquid portion of the applesauce, filtrates were prepared by the following procedure:

a. The sauce was thoroughly mixed and filtered by suction through a coarse filter paper.

b. An equal part of acetone was added to the filtrate. This resulted in the flocculation of the acetone-insoluble constituents, leaving a supernatant liquor.

c. The clarified filtrate was filtered through a fluted filtered paper to remove the floc, and the acetone was removed under vacuum at room temperature, leaving a cloudy liquor. This liquor was diluted volumetrically with acetone to produce a clear solution suitable for colorimetric measurement.

The light transmittance of the solution at 450 mμ was obtained, using a Beckman DU Spectrophotometer.[e]

[e] Manufactured by Beckman Instruments, Inc., South Pasadena, Calif.

**Determination of 5-hydroxymethyl-2-furaldehyde.** Ultraviolet light absorption data obtained on aqueous extracts of stored applesauce prepared in a manner similar to that previously described showed the presence of a strong absorption maximum at about 285 mμ and a minimum at about 245 mμ. These characteristics have been associated with the presence of 5-hydroxymethyl-2-furaldehyde (HMF) by various authors, including Wolfrom, Schuetz and Cavalieri *(9)*, Singh, Dean and Cantor *(8)* and Haas *et al. (2)*.

This compound is a result of sugar breakdown, and its occurrence in malic acid-fructose reaction mixtures, in which it appears to be a precursor to brown end products, was recently described by Livingston *(4)*.

Since no rapid method for the quantitative estimation of HMF has been published, the possibility of using the characteristic ultraviolet absorption of the compound as a means of determining its concentration was therefore investigated. HMF was synthesized from sucrose and oxalic acid by the method of Middendorp *(6)*. Aqueous dilutions of HMF were prepared, and their absorption at 285 mμ was determined. It was found that Beer's law was followed in the dilution range tested, since the optical density was a direct function of the HMF concentration. Inasmuch as the amount of HMF synthesized was too minute to allow accurate weighings, the concentration-optical density curve was calibrated using the extinction coefficient data given by Wolfrom *et al. (9)*.

The HMF content of applesauce was determined as follows:

a. The acetone-free, deflocculated liquor, prepared for the filtrate transmittance measurement was diluted 1:100 with distilled water.

b. The optical density of the resulting solution at 285 mμ was found using the Beckman DU Spectrophotometer.

c. The HMF content was calculated by reference to the standard curve.

**Determination of acidity.** Free acidity of the samples was determined using a Beckman Model H-2 pH Meter.[e] Total acidity was determined by electrometric titration against standard NaOH, and expressed as percent malic acid.

**Determination of pectin content.** It had been noted that a change in viscosity frequently accompanied the nonenzymatic discoloration of applesauce in storage. Since the breakdown of pectin involves a deesterification, the methoxy content of samples of applesauce was determined at intervals during the storage period. The enzymatic method of Hills, Ogg and Speiser *(2)*, using a fresh tomato pectase extract, was employed for this purpose.

**Viscosity measurement.** As a means of evaluating the change in consistency in applesauce in storage, the viscosity was measured using a Brookfield Viscometer.[f] This instrument measures the drag produced upon a spindle rotating at a definite constant speed while immersed in the sample. This drag produces a tension on a spiral spring; the extent of tension being indicated on a rotating dial by a pointer attached to the spindle shaft. By means of appropriate conversion tables, it is possible to express the dial readings in terms of the usual viscosity unit, i.e. the poise.

Since the applesauce appeared to undergo thixotropic changes during the course of the determination, as shown by continually decreasing viscosity values throughout the period of measurement, an empirical method was used to obtain comparable results. Accordingly, samples were cooled to 0° C. (32° F.) prior to the examination, and the No. 6 spindle which was operated at 20 r.p.m., was allowed to make 5 revolutions before the reading was recorded. Although measurement was made in the original jars, it was found that no correction factor was needed to compensate for the relatively small size of the container.

**Ascorbic acid determination.** The method of Robinson and Stotz *(7)* was followed to determine the extent of ascorbic acid

[c] Manufactured by the W. J. Fitzpatrick Co., 1001 W. Washington Blvd., Chicago 7, Ill.

[d] Manufactured by the Photovolt Corp., 95 Madison Ave., New York 16, New York.

[f] Manufactured by the Brookfield Engineering Laboratories, Porter St., Stoughton, Mass.

retention in samples to which ascorbic acid had been added as an antioxidant.

**Sugar determinations.** Using the Kolthoff-Kruisheer modification of the Luff-Schoorl method as given by Browne and Zerban *(1)*, analyses for sucrose, glucose, and fructose were carried out on samples of sweetened and unsweetened applesauce before and after the 11-months' storage period.

**Vacuum measurement.** The vacuum of all jars of applesauce utilized in these experiments was determined using an ordinary punchtype vacuum gauge. In order to standardize the measurement, all jars were left at 0° C. (32° F.) for at least 24 hours prior to measurement. Vacuum measurements were not corrected for gauge volume.

**Preparation of skin pigment extract.** An aqueous extract of McIntosh skin pigments was prepared by boiling several skins in water for a few minutes. The extract was filtered through paper and further clarified by passage through a filter candle. The extract was filled into ampules which were sealed, sterilized at 212° F. (100° C.) for 10 minutes, and stored at room temperature. The Beckman DU Spectrophotometer was used to determine the nature of color changes affecting the extract in storage.

**Fractionation of darkened applesauce.** To obtain more information about the nature of the substances produced in the storage darkening of applesauce, several samples of fresh, heat-browned, and storage-browned applesauce were fractionated by a method similar to that described by Livingston *(4)* in connection with malic acid-fructose reaction mixtures.

A clarified filtrate was first prepared in all cases by filtering samples of applesauce by suction through a coarse filter paper. The suspended material was flocculated by the addition of acetone; the floc was separated by filtration through a fluted filter paper. The acetone was then removed under vacuum, and the remaining liquor was chromatographed through a 1 : 1 alumina-Dicalite[6] column. In each case a colored band (Fraction A) was adsorbed on the column, and a colored filtrate resulted. (Fraction B).

Applesauce solids remaining after filtration were thoroughly washed with distilled water until the wash water was colorless. The remaining pulp was shaken with 10% NaOH to give a colored solution. (Fraction C).

## RESULTS AND DISCUSSION

**Effect of composition, variety, fill of container, and storage conditions on discoloration.** The effect of added chemical compounds upon the discoloration of applesauce stored at 25° C. (77° F.) is summarized in Table 1. It is apparent that the addition of malic acid resulted in an increase in both ring and body browning.

**TABLE 1**

**Reflectance of applesauce prepared from McIntosh apples, packed in baby food jars, containing added chemicals, and stored for eleven months at 25° C.[b]**

| Chemicals added | % Reflectance | |
|---|---|---|
| | Bottom | Top |
| None | 22.8 | 15.8 |
| Malic acid (1%) | 19.5 | 14.5 |
| Sucrose (3%) | 22.5 | 17.3 |
| Glucose (2%) | 21.8 | 16.5 |
| Fructose (2.2%) | 21.8 | 15.8 |
| Ascorbic acid (0.01%) | 24.0 | 23.3 |
| Ascorbic acid (0.10%) | 24.8 | 24.8 |

[b] The reflectance is indirectly proportional to the darkness of the applesauce.

The behavior of applesauce packed with added sucrose, glucose, and fructose did not differ materially from the controls. The addition of ascorbic acid not only reduced or eliminated the oxidative ring discoloration, but caused an initial bleaching of the applesauce and resulted in a product lighter in color than the control at all times during the storage period.

Table 2 summarized the discoloration data on the six varieties of Massachusetts apples studied. Baldwin apples underwent the most pronounced discoloration, while Cortland apples discolored least. The level of discoloration could not be correlated to apple acidity, tannin content or pigmentation.

**TABLE 2**

**Discoloration of applesauce prepared from six varieties of Massachusetts apples, packed in baby food jars and stored at ca. 25° C. (77° F.) for 18 months[1]**

| Variety | Total acid as % malic acid | % $R_0$[2] | % $R_t$[3] | % $R_b$[4] | Discoloration index |
|---|---|---|---|---|---|
| Cortland | 0.48 | 23.8 | 22.1 | 23.8 | 17 |
| Crab apples (Hyslop) | 0.93 | 22.1 | 19.0 | 20.7 | 31 |
| Red Delicious | 0.23 | 22.9 | 20.8 | 23.8 | 39 |
| McIntosh | 0.35 | 22.3 | 18.3 | 21.3 | 40 |
| Greening | 0.62 | 25.3 | 21.1 | 23.3 | 42 |
| Baldwin | 0.51 | 27.2 | 19.6 | 21.1 | 76 |

[1] Prepared from unpeeled apples.
[2] Reflectance of samples prior to storage.
[3] Reflectance of top portion of applesauce in jar.
[4] Reflectance of bottom portion of applesauce in jar.

The effect of fill of container upon the development of discoloration in storage is graphically illustrated in Figure 1. Discoloration indices of applesauce made from McIntosh apples, and packed with 10, 15 and 40 ml. headspaces, were measured at monthly intervals over an 11-months' period. To prevent any possible diffusion of outside gases into the containers in the case of the 10-ml. headspace jars, the latter were stored in sealed No. 10 tin cans filled with deaerated water. It should be noted that these jars showed no ring discoloration even after a 2-years' storage period. The discoloration measured was entirely of the body or diffused type.

This evidence, in conjunction with the data on the ascorbic acid pack, appears to confirm Yourga's *(10)* conclusion in the case of discolored strained carrots that the ring browning is strictly an oxidative reaction.

As indicated in Figure 2, storage temperature was found to have a marked effect upon the rate of discoloration. A slight ring browning developed in the

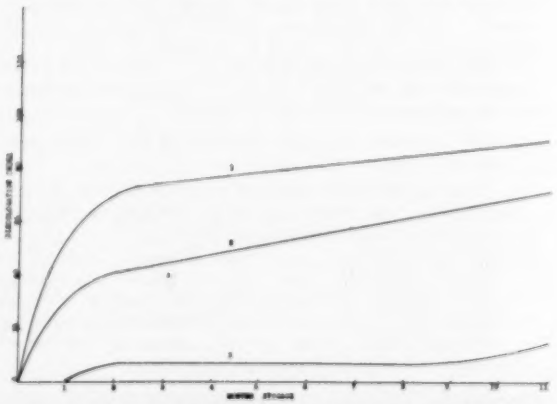

**Figure 1. Effect of headspace volume on the discoloration of applesauce in baby food jars, stored at 25° C. (77° F.)**
**1 = underfilled 2 = regular fill 3 = overfilled**

[6] A diatomaceous earth filter-aid.

jars stored at 0° C. (32° F.). At 36° C. (97° F.) pronounced body darkening took place. It is noteworthy that the overfilled jars stored at room temperature showed better color retention than the ordinary jars held at 0° C. (32° F.). This observation would appear

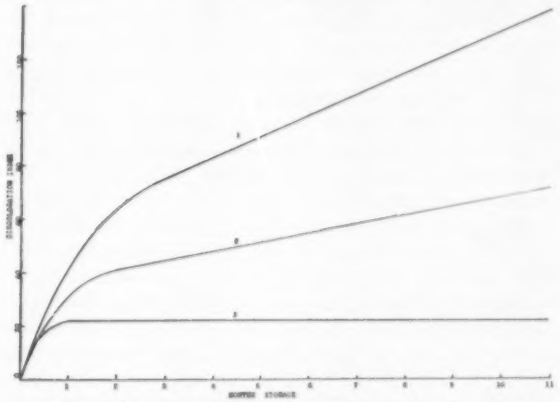

**Figure 2. Effect of storage temperature on the discoloration of applesauce in baby food jars**
**1 = 36° C. (97° F.) 2 = 25° C. (77° F.) 3 = 0° C. (32° F.)**

to indicate that storage temperature is not a critical factor in the development of oxidative browning. Storage temperature does appear to be the controlling factor in the development of the body discoloration.

Since apple skin pigments extracted in cooking the applesauce might contribute to the darkening in the course of their degradation, several packs of applesauce were prepared from peeled apples and stored. As shown in Table 3, applesauce prepared from 3 varieties of peeled apples reached a higher level of discoloration than that prepared from unpeeled apples. It would appear that the presence of skin pigments and their degradation products in the sauce made from unpeeled apples partially masked the extent of ring browning which occurred, thus resulting in a product less obviously discolored.

**Physical and chemical changes in storage.** The results of measurements and determinations performed on sweetened and unsweetened applesauce stored at room temperature for 11 months are tabulated in Table 4. Although the analyses were performed at monthly intervals, only the initial and terminal data are presented. It is observed that storage at room temperature did not cause significant changes in vacuum, HMF content, pH, or viscosity. A slight increase in acidity during the storage period was found to occur. This was accompanied by a slight decrease in the transmittance of the filtrate as well as in the methoxy content of the sauce. The sugar distribution was materially affected by storage, there being a decrease in total sugar

**TABLE 3**

**Effect of peeling on the discoloration of applesauce stored at Ca. 25° C. (77° F.) for 18 months**

| Variety | Discoloration index | |
|---|---|---|
| | Peeled | Unpeeled |
| McIntosh | 42 | 40 |
| Baldwin | 60 | 76 |
| Red Delicious | 51 | 39 |
| Greening | 58 | 42 |

**TABLE 4**

**Storage changes in sweetened and unsweetened applesauce prepared from McIntosh apples, packed in baby food jars, and stored for eleven months at 25° C. (77° F.)**

| Determination | Unsweetened | | Sweetened | |
|---|---|---|---|---|
| | Before storage | After storage | Before storage | After storage |
| Vacuum (inches) | 17 | 16 | 17 | 14 |
| Reflectance-top (%) | 22.8 | 15.8 | 21 | 13.8 |
| Reflectance-bottom (%) | 22.8 | 22.8 | 21 | 20.3 |
| Transmittance (%) | 85.0 | 73.0 | 85.0 | 79.5 |
| HMF (mg./100 ml.) | 21.6 | 21.6 | 20.6 | 21.2 |
| pH | 3.7 | 3.7 | 3.8 | 3.8 |
| Malic acid (%)[m] | 0.19 | 0.22 | 0.19 | 0.20 |
| Methoxy (%) | 0.047 | 0.046 | 0.044 | 0.036 |
| Viscosity (poise) | 400 | 300 | 400 | 320 |
| Total sugars (%) | 13.6 | 11.1 | 19.8 | 18.5 |
| Reducing sugars (%) | 7.2 | 8.9 | 8.6 | 11.1 |
| Sucrose (%) | 6.4 | 2.2 | 11.2 | 7.4 |
| Glucose (%) | 3.3 | 4.2 | 2.3 | 3.1 |
| Fructose (%) | 3.9 | 4.7 | 6.3 | 8.0 |
| Ascorbic acid (mg. %) | 0 | 0 | .... | .... |
| Ascorbic acid (mg. %) | 10 | 0.2 | .... | .... |
| Ascorbic acid (mg. %) | 100 | 76.5 | .... | .... |

[m] Total acidity expressed as % malic acid.

content in each case, as well as inversion of the sucrose to the glucose and fructose. Ascorbic acid analyses indicated that there was no ascorbic acid present in the sauce to which none was added; while a 2% retention occurred at the 0.01% level of addition, and a 76% retention at the 0.10% level.

The effect of fill of container and storage temperature upon a number of properties are summarized in Table 5. Except for the measurements of darkening, i.e. reflectance and transmittance, there appears to be little difference between the overfilled and underfilled samples. Storage temperature plays a more important role, however, in influencing the extent to which the various

**TABLE 5**

**Storage changes in sweetened applesauce prepared from McIntosh apples, packed in baby food jars and stored for eleven months**

| Determination | Before storage | After storage | | | | |
|---|---|---|---|---|---|---|
| | | Fill of jar | | Storage temperature | | |
| | | Overfilled | Underfilled | 0° C. | 25° C. | 36° C. |
| Vacuum (inches) | 17 | 15 | 17 | 17 | 14 | 12 |
| Reflectance-top (%) | 21.0 | 19.5 | 12.8 | 18.8 | 13.8 | 7.9 |
| Reflectance-bottom (%) | 21.0 | 20.0 | 18.8 | 19.5 | 20.3 | 8.4 |
| Transmittance (%) | 85 | 76 | 67 | 81 | 73 | 67 |
| HMF (mg./100 ml.) | 20.6 | 21.9 | 22.1 | 22.8 | 21.2 | 86.5 |
| pH | 3.8 | 3.6 | 3.7 | 3.7 | 3.8 | 3.6 |
| Malic acid (%)[n] | 0.19 | 0.20 | 0.20 | 0.18 | 0.20 | 0.27 |
| Methoxy (%) | 0.044 | 0.039 | 0.042 | 0.037 | 0.036 | 0.028 |
| Viscosity (poise) | 400 | 370 | 300 | 360 | 320 | 180 |

[n] Total acidity expressed as % malic acid.

changes were found to occur. It is noted that with increased storage temperature, there was a decrease in jar vacuum, a marked increase in darkening, a considerable production of HMF, a lowering in pH with a resulting increase in acidity, and a loss in methoxy content with an accompanying decrease in viscosity.

**Degradation of skin pigments in storage.** Storage of skin pigment extracts from McIntosh apples showed that a rapid loss in the red color occurred. This color change was accompanied by an increase in browning, resulting in an over-all darkening of the extract (Figure 3).

**Colored fractions extracted from applesauce.** Using the procedures previously described, at least 3

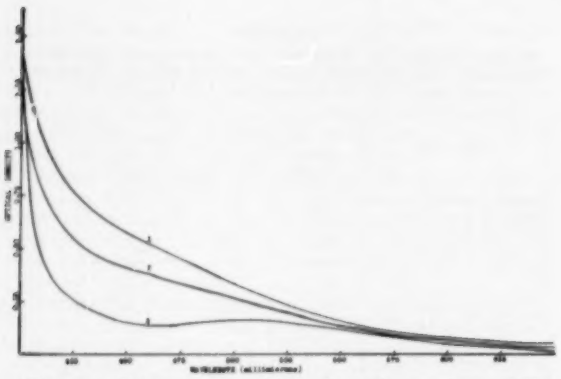

**Figure 3. Changes in the visible absorption spectrum of McIntosh skin pigment extract stored at 25° C. (77° F.)**
**1 = after 10 months' storage**
**2 = after 1 month's storage**
**3 = before storage**

fractions each were isolated from fresh applesauce, storage-browned applesauce and applesauce browned by exposure to 60-70° C. (140-158° F.) for 96 hours. Some of their characteristics are listed in Table 6. It is apparent that the chemical effects of heat-induced browning are not entirely comparable to the effects of storage-induced browning. The green pigment recovered from the filtrate of applesauce could also be recovered from storage-darkened applesauce, but not from the heat-browned product. However, at least enough brown pigment was present in the tissue of the storage darkened sauce to mask any alkali-soluble green pigment which may have been present.

**TABLE 6**
**Colored fractions recovered from samples of applesauce**

| Sample | Fractions | | |
|---|---|---|---|
| | From filtrate | | From tissue |
| | A | B | C |
| Fresh applesauce | Green pigment $H_2O$ soluble adsorbed on $Al_2O_3$ (turns brown on column); eluated by 1% $H_2SO_4$ | Yellow pigment $H_2O$ soluble not adsorbed on $Al_2O_3$ | Green pigment $H_2O$ insoluble soluble in 10% NaOH |
| Applesauce held at 60-70° C. for 96 hours | Brown pigment acetone insoluble; $H_2O$ soluble; $C_2H_5OH$ soluble; adsorbed on $Al_2O_3$ (turns brown on column); eluted by 1% $H_2SO_4$ | Yellow pigment acetone insoluble; $H_2O$ soluble; $C_2H_5OH$ soluble; not adsorbed on $Al_2O_3$ | Brown pigment $H_2O$ insoluble soluble in 10% NaOH |
| Storage-browned applesauce | Green pigment $H_2O$ soluble adsorbed on $Al_2O_3$; eluted with 1% $H_2SO_4$ | Yellow pigment $H_2O$ soluble not adsorbed on $Al_2O_3$ | Brown pigment $H_2O$ insoluble soluble in 10% NaOH |

Spectrophotometric analysis of the fractions recovered from applesauce filtrates did not reveal any significant absorption characteristics. General absorption curves were obtained in the visible range, and nearly all fractions examined in the ultraviolet range exhibited the maximum absorption at 285 mμ, indicating the presence of HMF.

## SUMMARY AND CONCLUSIONS

Chemical and physical changes taking place in applesauce prepared and stored under different conditions were studied. The surface darkening, reported to occur in commercially packed applesauce in baby food jars, was observed to be an oxidative reaction. This darkening was entirely prevented by the elimination of oxygen from the headspace.

The nature of the reactants involved is not known, although sugars were found to contribute slightly to the rate of this darkening. The diffused darkening that took place at elevated temperatures, or over prolonged storage periods, is thought to be due to a number of nonoxidative reactions. Among these, sugar and pigment degradations represent possible darkening mechanisms. Storage temperature is of greater importance in nonoxidative than in oxidative darkening.

Storage at room temperature affected, in addition to the color, the acid, pectin and sugar constituents of the applesauce. Inversion of the sucrose was found to occur, as well as a loss in total sugar content. With increased storage temperature, there was a loss in jar vacuum, a marked increase in darkening, considerable development of 5-hydroxymethyl-2-furaldehyde, an increase in acidity and a breakdown of the pectin fraction, accompanied by a reduction in viscosity.

Fractionation of colored components extracted from samples of applesauce indicated that a more general browning occurs when darkening is induced over a short period of time at elevated temperatures, than when it results from extended storage at normal temperatures.

The intensity of body and ring browning differed in applesauce made from six varieties of Massachusetts apples tested. Using peeled apples instead of unpeeled apples in preparing the sauce was of no value in reducing the discoloration.

**Acknowledgments**

The authors are indebted to Dr. Irving S. Fagerson, Mrs. Cilla Livingston, and Mrs. Nancy Glazier for their assistance in certain phases of this work and to Mr. Milton P. Baldauf for the ascorbic acid determinations.

## LITERATURE CITED

1. Browne, C. A., and Zerban, F. W. *Physical and Chemical Methods of Sugar Analysis.* 1948, John Wiley and Sons, New York.
2. Haas, V. A., Stadtman, E. R., Stadtman, F. H., and Mackinney, G. Deterioration of dried fruits. I. The effect of sugars and of furfurals. *J. Am. Chem. Soc.*, **70**, 3576 (1948).
3. Hills, C. H., Ogg, C. L., and Speiser, R. Determination of the methyl ester content of pectin. *Ind. Chem. Anal. Ed.*, **17**, 507 (1945).
4. Livingston, G. E. Malic acid-fructose reaction. *J. Am. Chem. Soc.*, **75**, 1342 (1953).
5. Livingston, G. E., and Vilece, R. J. Measuring discoloration of pureed foods in glass tubes. *Food Technol.*, **7**, 272 (1953).
6. Middendorp, J. A. Hydroxymethylfurfural. *Rec. Trav. Chim.*, **38**, 1 (1919). (*Chem. Absts.* 13, 2344).
7. Robinson, W. B., and Stotz, E. The indophenol-xylene extraction method for ascorbic acid and modification for interfering substances. *J. Biol. Chem.*, **160**, 217 (1945).
8. Singh, B., Dean, G. R., and Cantor, S. M. The role of 5-(hydroxy-methyl) furfural in the discoloration of sugar solutions. *J. Am. Chem. Soc.*, **70**, 517 (1948).
9. Wolfrom, M. L., Schuetz, R. D., and Cavalieri, L. F. Chemical interactions of amino compounds and sugars. III. The conversion of D-glucose to 5-(hydroxymethyl) 2-furaldehyde. *J. Am. Chem. Soc.*, **70**, 514 (1948).
10. Yourga, F. J. How to prevent off-color in glassed carrots. *Food Inds.*, **20**, 47 (1948).

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## SELECTED ABSTRACTS

(Continued from page 22 preceding technical papers)

discussed in detail and a method of detn. by n. v. absorption is outlined.

### SUGARS

**Sugar oxidation: Saccharic and oxalic acids by the nitric acid oxidation of dextrose.**

MEHLTRETTER, C. L., AND RIST, C. E. *J. Agr. Food Chem., 1,* 779-83 (1953).

Saccharic acid can be prepd. in a yield of 41% by oxidizing 1 mole of dextrose with 4 moles of concd. $HNO_3$ at 55° to 75° C. for 1 hr. After the removal of saccharic acid as its insol. acid salt, the by-product sugar acids formed in the oxidation may be converted to oxalic acid in a yield of 44% of theory. For this purpose $HNO_3$ and a V catalyst are employed. Preliminary work has shown saccharic acid to be particularly effective as a sequestrant for metal ions in alk. solns. As saccharic acid is nontoxic, it also has potential value for application in the food industry.

## ORGANIC CHEMISTRY

**Recent research on oxidation of monoethenoid fatty acids and esters.**

SKELLON, J. H. *Chemistry & Industry,* 1047-9 (1953).

A brief review of later progress and current research on the catalytic autoxidation of component fatty acids, chiefly monoethenoid fatty acids and esters. Systematic investigations in progress include catalytic oxidations under various conditions of Me, Et, Pr, Bu and glycol esters of natural oleic, petroselenic, erucic and ricinoleic acids and their *trans*-isomers.

### PHYSICAL RESEARCH

**Melting phenomena of a surface of monomolecular thickness.**

BEISCHER, D. E. *Bibliog. Tech. Repts., 20,* 55 (1953).

The direct observation of the phase transition of a monolayer of stearic acid in radioautographs confirms many earlier observations of the melting phenomena of a surface. The surface has no sharp m.p. and the transition order-disorder takes place at a considerably lower temp. than in the bulk phase.

**Aerosol technic for the study of macromolecules with the electron microscope.**

ROBERTIS, E. DE., FRANCHI, C. M., AND PODOLSKY, M. *Biochim. et Biophys. Acta, 11,* 507-16 (1953).

A technic was developed for dispersing the macromol. material by turning it into a monodisperse aerosol, and pptg. it electrostatically on standard grids for observation with the electron microscope. The general setup used is described together with control expts. indicating the size and distribution of the aerosol.

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**Preparations for Los Angeles Meeting in June Entering Final Stages.** The abstracts of technical papers are in, the exhibitors have begun to list their wares, chairmen of IFT committees have started gathering their forces, and in the next few months the shadows of events to come will be sharply outlined. The February issue features the exhibits section of the annual meeting.

**Progress Report on Exhibits.** As of this writing (late December 1953) a few choice exhibit spaces still remain open. On account of the unprecedented demand for space at this Convention, we are compelled to allot the remaining space strictly on a priority basis.

Following is a listing, as of this date, of the exhibitors to whom space has already been assigned, together with a brief digest of the products which they expect to show. It is quite obviously a very representative listing of the Food Industry. Perhaps, at the time you read this, *your* Company is the only one which has not acted soon enough to secure space. We hope not, but please do not delay.

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The starred (*) exhibitors had not sent in their "Product list" at the time of this writing.

(Continued on page 30)

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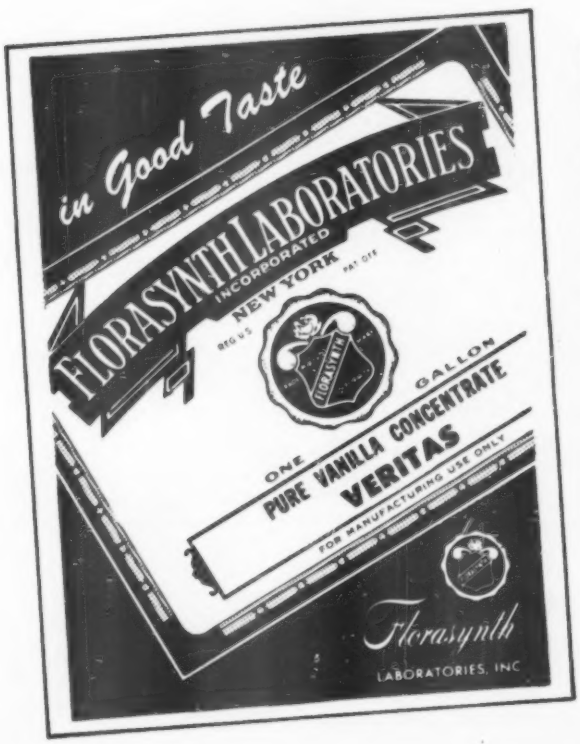

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(Continued on page 32)

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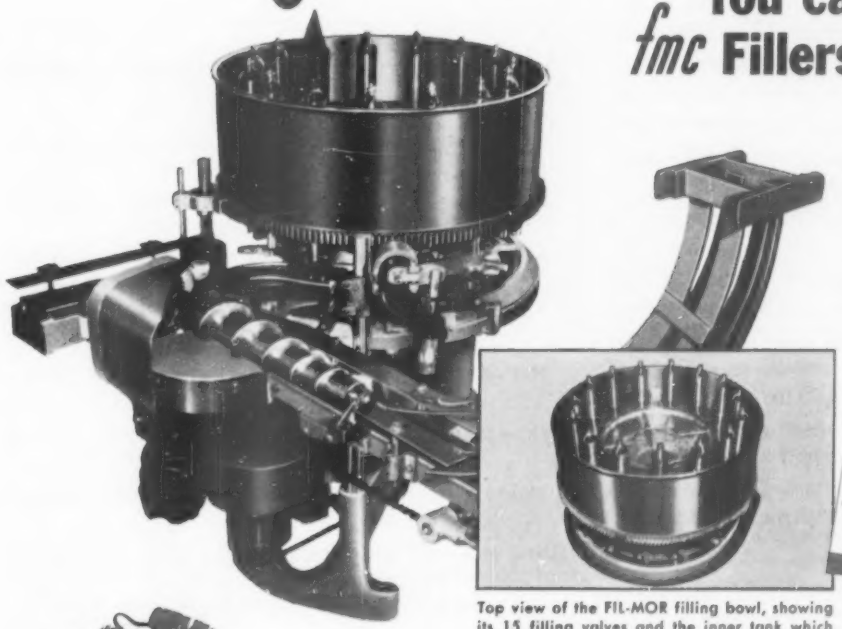


Top view of the FIL-MOR filling bowl, showing its 15 filling valves and the inner tank which controls the liquid level in outer bowl.

**FOOD MACHINERY AND CHEMICAL CORPORATION**

*Canning Machinery Division*

**General Sales Offices:**

**WESTERN:** SAN JOSE, CALIFORNIA **EASTERN:** HOOPESTON, ILLINOIS

# extend SHELF LIFE!

# retard RANCIDITY!

## ...on High-Fat Low-Moisture Foods!

● As you know, potato chips, prepared mixes, nuts, baked goods, powdered soups and many other products that are high in fat and low in moisture are often spoiled by rancidity and the development of oxidative "off" flavors. And these factors reduce the shelf life and profit margin of many food products.

*These problems may be avoided by the proper use of a new food grade salt with antioxidant, developed as a result of years of laboratory research—Diamond Crystal Salt with ANTIOXIDANT!*

New Diamond Crystal Salt with *Antioxidant* is as simple to use as common table salt. If sodium chloride is used in your processing, this new salt will fit into your operation without extra equipment or labor.

Diamond Crystal Salt with *Antioxidant* is economical, too! The extra cost involved in salting potato chips is only about 7¢ per 100 lbs. of chips! This is a small cost to minimize returned goods.

The effectiveness, ease of use and economy of this new salt will more than justify its test in your operation. Samples are available upon request. Send for yours today!

**Write to Technical Director, Diamond Crystal Salt Co., St. Clair, Michigan.**

**DIAMOND CRYSTAL SALT with Antioxidant**


## ANNUAL MEETING BULLETIN BOARD

(Continued from page 30)

VAN AMERINGEN HAEBLER, INC.
True fruits extracts; vanilla concentrates; imitation flavors; SEALVA "sealed-in" powdered flavors.

*WALKER-WALLACE DIV., A.P.V. CO., INC.

*WALLACE & TIERNAN

WYANDOTTE CHEMICALS CORP.
Detergents, sanitizers, disinfectants. WYANDOTTE ANTIBAC: STERI-CHLOR, KROMET, TRI-BAC, G. L. X., SR-10, WYANDOTTE DUAL-PAK (new).

Due to space limitation, it was impossible to give a complete listing of all *products*. The list shown above, however, is sufficient to indicate that this is going to be one of the most interesting exhibit areas that we have yet had. Don't fail to see them all. And if you want to *sell* the Food Industry, don't wait until the last minute to apply for space.

**Dehydrated Foods Exhibit.** The Quartermaster Food and Container Institute for the Armed Forces exhibit will feature dehydrated fruit and vegetable products with particular emphasis on new and improved items developed through the Institute research program. Of particular interest will be dehydrated sweet corn, dehydrated green beans and a line of precooked, rapidly rehydrating, dehydrated soups. The quality of the samples which will be presented will be a plesant surprise to those not familiar with recent advances in the field.

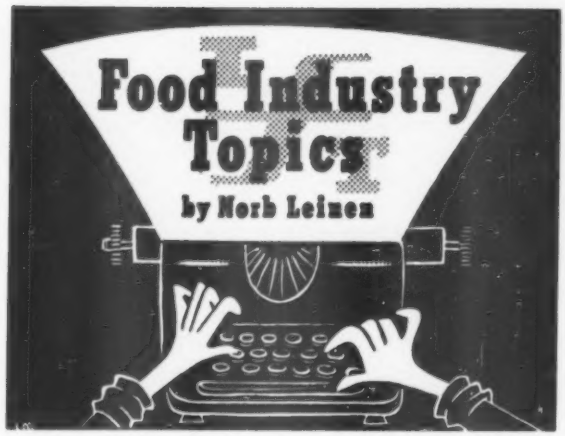
## FUTURE DATES FOR FOOD TECHNOLOGISTS

**1954**

| | |
|---|---|
| February 1954 | Annual Meeting of the National Soup Mix Association, Chicago, Illinois |
| February 1-4 | Frozen Food Industry Convention and Exhibition, New York, New York |
| April 22-23 | National Meeting of the American Dry Milk Institute, Cleveland, Ohio |
| April 27-28 | Annual Meeting of the National Cheese Institute, Chicago, Ill. |
| May 2-5 | Annual Meeting of the National Fisheries Institute, Cleveland, Ohio |
| *May 16-19 | Flavoring Extract Manufacturers' Association, Biltmore Hotel, New York, N. Y. |
| May 19 | Fruit and Syrup Manufacturers' Association, New York, N. Y. |
| *May 26-28* | *Fourth Annual Convention, Australian Regional Sections, Institute of Food Technologists, Leura, New South Wales, Australia.* |
| June 23-25 | Seventh Annual Meeting of the Research and Development Associates, Food and Container Institute, Los Angeles, California |
| **June 27 to July 1, 1954** | **Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California** |

* This is a correction in the date printed in the January issue.

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)




***. . . in the public interest***

Several months ago we made mention of the forthcoming Tenth International Congress of Agricultural and Food Industries and the concurrent Third International Congress of the International Federation of Fruit Juice Producers—both to take place in Madrid, Spain, between May 31 and June 7, 1954. Now, your columnist is happy to report, more details are available. The letter reprinted below contains all of the necessary information.

A l'occasion du Xème CONGRES INTERNATIONAL DES INDUSTRIES AGRICOLES ET ALIMENTAIRES qui se tiendra à MADRID (Espagne) du 31 Mai au 7 Juin 1954, la FEDERATION INTERNATIONALE DES PRODUCTEURS DE JUS DE FRUITS tiendra son 3ème CONGRES INTERNATIONAL. Le programme examiné au cours d'une conférence qui a eu lieu récement à ZURICH (Suisse), sera définitivement mis au point par le COMITE DE DIRECTION qui se réunira à BRUXELLES (Belgique) le 12 Décembre 1953.

"D'ores et déjà, les discussions porteront sur l'intérêt de la protection légale des JUS DE FRUITS, sur la composition et les analyses des JUS DE FRUITS CONCENTRES, sur l'utilisation des JUS DE FRUITS dans les boissons, sur la composition des aromatiques naturels alimentaires tirés des fruits, sur les nouvelles observations recueillies sur l'oxydation dans la production et la conservation des JUS DE FRUITS, sur la méthode de conservation des jus de fruits matière première, sur le revêtement intérieur, sur la classification des informations médicales par catégorie de jus de fruits, sur la création d'un signe international devant être associé à la marque nationale représentative des jus de fruits conforme à la législation appliquée à ce produit, sur les améliorations apportées aux législations appliquées aux jus de fruits.

"Les conditions d'admission, la désignation des rapporteurs, l'horaire des discussions, seront ultérieurement communiqués, mais, dès à présent, ceux qui voudront participer aux travaux de ce Congrès devront en retenir la date.

REMERCIEMENTS"

◆ ◆ ◆

The nation's largest processing business—the food industry—could use thousands of engineers with special training in the

Combat the oxidative deterioration of

Waxes

with **Tenox** EASTMAN FOOD-GRADE ANTIOXIDANTS

For complete information about the effectiveness of Tenox in preserving various waxes, write to

**EASTMAN CHEMICAL PRODUCTS, INC.**
*Subsidiary of Eastman Kodak Company*
**KINGSPORT, TENNESSEE**



## *Ac'cent Technologists Seek New Customers For You*

As the food processing business grows, so does Ac'cent. Thus, Ac'cent's research and development staff is constantly seeking improved methods of enhancing the natural flavor of your product. These men were the pioneers in the monosodium glutamate field, and the results of their continuing research are always available to you. They will provide specific solutions to your specific flavor problems, even to the point of designing new machines for you. Scores of food processors who have used this service have enjoyed immediate results in increased sales.

This is only one of the many advantages offered by Ac'cent. Next time you order monosodium glutamate, be sure to specify Ac'cent, made by the world's leading producer of monosodium glutamate.

Ac'cent is monosodium glutamate in its purest form: convenient, uniform crystals. The natural glutamic acid present in all foods dissipates in shipping, storage and processing. Ac'cent is the pure sodium salt of glutamic acid, vital in retaining nature's original flavor in food. Ac'cent adds *no* flavor of its own.

**Ac'cent®**
PURE MONOSODIUM GLUTAMATE
*...makes processed food taste better!*

**AMINO PRODUCTS** Division of International Minerals & Chemical Corporation, 20 North Wacker Drive, Chicago 6, Ill.

## FOOD INDUSTRY TOPICS

field, but few persons know the jobs even exist. This information comes from Mr. Curtis E. Maier, general chairman of the Food Engineering Council of Illinois Institute of Technology, Chicago, and general manager of research for Continental Can Co. The Council is composed of Midwestern technical leaders of national food industries. To help solve the shortage, Mr. Maier said the council plans an extensive drive to recruit students for the IIT food engineering curriculum, created 5 years ago. The food engineering needs of the nation's 40,000 food processing establishments now are being met by hiring chemical, mechanical, and other types of engineers who are being trained on the job, Mr. Maier pointed out. He said the council at IIT is trying to familiarize potential engineering students with the needs of the industry in production, preparation, processing, handling, and distribution of foods. Plans were outlined to promote the field in commissaries at separation centers as well as by direct contact with high school students, science teachers, and counselors. The council also plans to urge cooperating firms to set up summer work programs to acquaint students with operations in the food industry and among its suppliers.

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Dr. Ernest Guenther, vice president and technical director of Fritzsche Brothers, Inc., recently returned from a 4-month survey of Latin American essential oil production, summed up his impressions of the South American situation. The most significant development in his opinion was the fact that essential oil production by underprivileged and underdevcloped countries appears to be rapidly coming to an end. He felt that this was especially true throughout South America where the costs of labor and the standards of living are on an upward trend which will likely be reflected in higher priced oils. "One is increasingly made aware," stated Dr. Guenther, "of the fact when visiting South America that our industry is comprised of two parts—the technical phase, which includes distillation, manufacturing, etc., and the agricultural phase which has often been sadly neglected. The mere fact that a country like Brazil, for example, offers a great variety of favorable climate and soil conditions does not mean necessarily that essential oils can be produced there advantageously. The reason is quite simple: other crops—coffee, rice, foodstuffs—offer far greater profits to the growers who, today, can be persuaded to produce essential oils only if long range contracts can be made at favorable prices. At present, essential oil production is too risky, with too many price fluctuations to make it of interest to the growers. Furthermore, much 'know-how' must be acquired before they can produce successfully and this means years of learning and gaining experience, and, not infrequently, considerable loss of money invested."

The cheaper interior lands of South America, according to Dr. Guenther, might attract future essential oil development, but in such regions labor presents a serious problem. Housing, sanitation, schools, readily available food supplies and many of the other needs of modern living would have to be provided to induce labor in sufficient numbers to give up the ready jobs and good wages of South America's booming metropolitan areas for the more restricted life of the agricultural interior. "Such undertakings," concludes Dr. Guenther, "would entail large capital investments and could only be justified by the prospect of much higher prices than now prevail. As it is, most of the oils produced in Brazil, are consumed within Brazilian borders and at higher prices than the same oils are now bringing in the world markets."

### . . . *things new under the sun*

Struvites! Fresh struvites! Get your struvites here! Seriously, though, if you're a fish canner, you could be losing money because of struvites says the Scientific Salting Co., 1530 Hadley St., St. Louis 6, Mo. Struvites, in case you didn't know, are more or less harmless crystals that are present in varying amounts in today's canned fish. They are tasteless, colorless, quite insoluble in water, but are dissolved by stomach acids. But struvites have one bad feature—they look like *glass*, could injure the mouth, and, at best, have an uncomfortable grittiness about them. The crystals are formed in canned fish within weeks or months after the seafood has been processed by three chemical radicals which occur naturally in fish and shell fish. These radicals are magnesium, ammonium, and phosphate. Now, however, help is here with a patented Anti-Struvite Salt developed through the efforts of the Gorton-Pew Fisheries Co., Ltd. With the help of the Scientific Salting Co., it is now being made and exclusively sold in correctly proportioned tablets of sodium hexametaphosphate and sodium chloride. The tablets, which are clean, easy to handle, and inexpensive, will prevent the formation of struvites and provide the amount of salt individual processors desire in producing canned fish. The addition of the small amount of Anti-Struvite Salt tablet to the product reportedly causes no adverse effects on color, texture, or flavor, and has already been used economically and successfully in packs of lobster, shrimp, crab, flaked fish, and even canned codfish for babies.

◆ ◆ ◆

Two new multi-color printed REDBOW packages by Arvey Corporation, Chicago, combine self-display and exact reproductions of nuts to provide tempting product appeal. Four-color rotogravure printing adds brilliance to tough, transparent cellophane and produces halftones of startling realism and fine reproduction. Design provides spot for dealer fill-in of price. The packaging consists of a simple overwrap on a reinforced liner.

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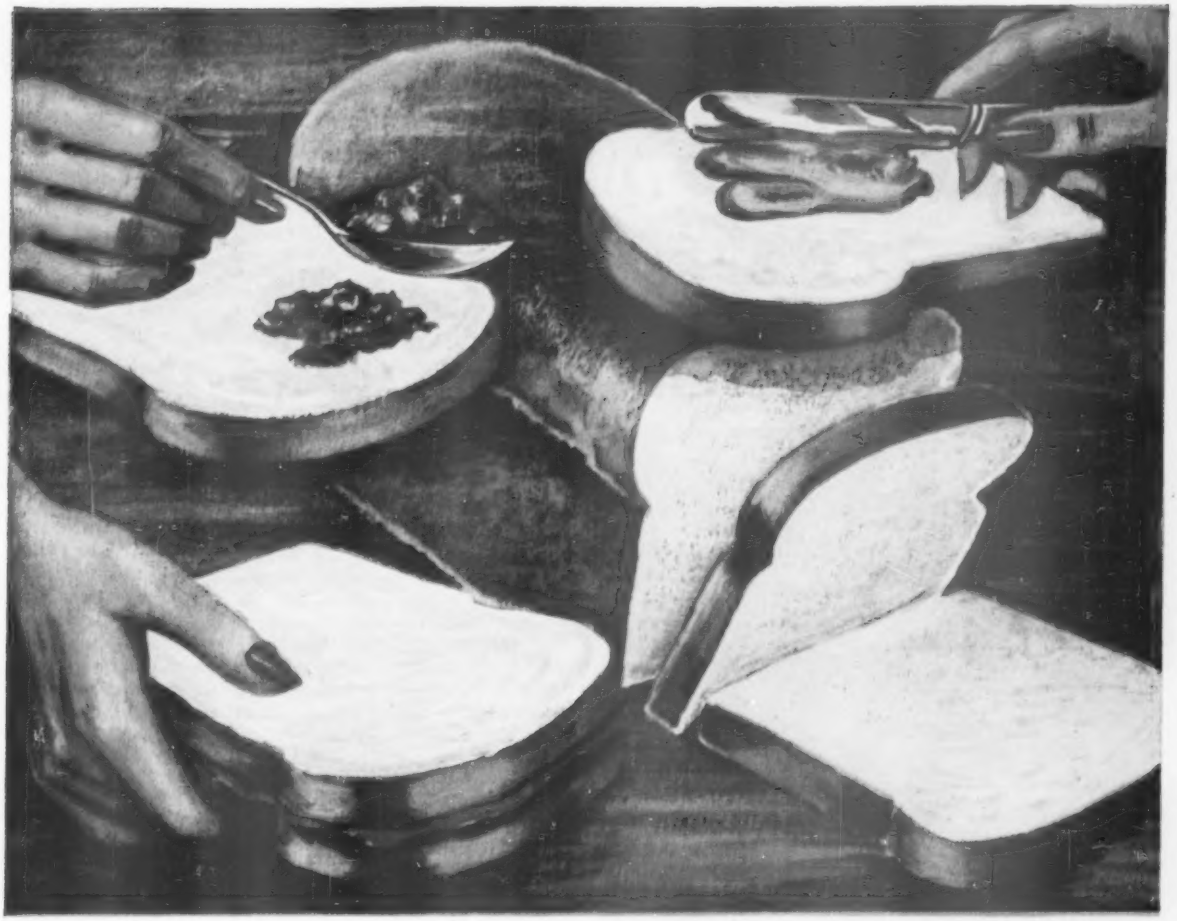
Fast, continuous straining of oversize particles from process stream is accomplished at low cost by the new "Bantam" strainer designed and produced by Merco Centrifugal Co., 150 Green St., San Francisco 11, Cal., an affiliate of the Merrill Co., Engineers. The new unit features small space and power requirements, prevents combination of product by continuous removal of particles. It is designed to handle fibrous or viscous slurries and is equipped with motor-driven scrapers (or brushes) to prevent particles from plugging openings. The simple, low-speed design of the new strainer assures low maintenance cost. Primary applications of the "Bantam" model are in the food and chemical process industries where maximum pulp or particle size is important or where straining of feeds to centrifuges and other critical machines is required.

◆ ◆ ◆

Prospect of a satisfactory demand for products of its corn refining division has improved the 1954 business outlook of the A. E. Staley Manufacturing Co., Decatur, Ill., corn and soybean processor, according to Pres. A. E. Staley, Jr. Demand for both food and industrial starches and for corn sweeteners was at a very satisfactory level during the 4 months through November

(Continued on page 36)



# Today's Bread is Better Than Ever

**Secret of Bread that Stays Fresh Longer,**
**Toasts and Tastes Better—is Sweetose,® the Unique Corn Syrup**

**AMERICA'S LEADING BAKERS USE THESE STALEY PRODUCTS**

***Corn Syrup***—Sweetose Brand—High conversion corn syrup that imparts softer texture, higher moisture retention.

***Lecithin***—Remarkable emulsifier that improves handling and softens crumb texture.

***Corn and Soybean Oil***—Effective shortening agents at lower cost.

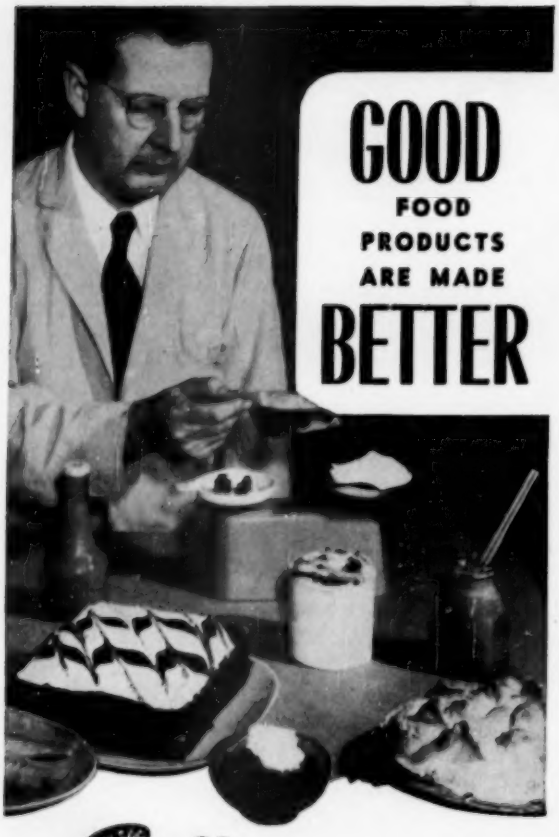
Sweetose puts new buy-appeal in your bread's taste, texture and appearance . . . enhances eating qualities, increases shelf life. And Staley's automatic handling of Sweetose means you actually *cut costs* while you boost sales. No wonder progressive bakers are going to Sweetose —and realizing greater profits.

**A. E. STALEY MFG. CO., *Decatur, Ill.***

PRODUCTS FROM CORN
Staley's

*Industries Served by Staley Products*

**BAKING • CONFECTIONERY • ICE CREAM • FOOD PROCESSING**



GOOD FOOD PRODUCTS ARE MADE BETTER

with SeaKem "COLLOIDS OUT OF THE SEA"*

Does your product have all the appetite and sales appeal it needs? . . . Can your manufacturing process be simplified or speeded up? . . . Has a really tough improvement problem got you ready to throw in the towel?

Then it's time right now to discover how SeaKem Stabilizers can help you.

The check list at right shows a few of the positive ways these remarkable colloids are improving dozens of items as widely varied as bakery product stabilizers, chocolate milk, dessert mixes, ice cream stabilizers, pet foods, pie fillings (fruit), puddings, sauces, sausages, and syrups.

Whatever your food product may be, if the function you are interested in is listed, it will pay you to get full information on SeaKem "Colloids Out of the Sea". For prompt, non-obligating recommendations, just write outlining your problem.

Here are a few of the functions being performed by SeaKem Stabilizers for an ever-growing list of food products:

- Binding
- Bodying
- Emulsifying
- Gelling
- Modifying
- Stabilizing
- Suspending
- Thickening
- Custardizing milk and products containing milk solids
- Improving mouth feel and flavor
- Increasing efficiency of component ingredients
- Modifying ice crystal growth
- Physical and anti-oxidant protection

* SeaKem is the registered trademark for the standardized, water-soluble, sea plant extractives manufactured by the Seaplant Chemical Corporation. Refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem "Colloids Out of the Sea" are light amber to colorless, free-flowing flaky powders. Available in a variety of types suitable for use in either dry or liquid applications, SeaKem Stabilizers have won acceptance on the basis of proven advantages with leading food manufacturers and processors.

Send for latest SeaKem Technical Bulletins

SEAPLANT CHEMICAL CORPORATION
62 David St., New Bedford, Massachusetts


## FOOD INDUSTRY TOPICS

(Continued from page 34)

1953, according to Mr. Staley. Assuming that there is no appreciable decline in general business activity, the demand for corn products should continue at satisfactory levels in 1954, believes the company, though at a somewhat lower rate than prevailed in the closing months of 1953. The supply appears adequate. The soybean supply outlook, however, is not as promising. According to the company, the late summer drouth cut harvest production appreciably below last year's level, and bean prices at harvest time—based largely on the prices obtainable for soybean oil and meal—were well below the government support level, although they advanced sharply later. The usual harvest movement was curtailed sharply as these crop and price factors prompted many growers to hold soybeans in storage on the farm. As a result, the Staley company's soybean inventory and use of bank credit fell well below the normal seasonal peak in 1953.

◆ ◆ ◆

More than 40 leading food manufacturers now are or soon will be using the new quality protection seal currently being offered by Reynolds Metals of Louisville, Ky., to users of their aluminum foil packaging. The seal—a small shield carrying the words "quality protected by Reynolds Wrap aluminum packaging"—is a guarantee to the purchaser that she is getting the same excellent protection against loss of freshness in a commercially produced product that Reynolds household foil (trade name: Reynolds Wrap) gives to perishable foods in the home kitchen. Motivating this new seal is the consumer education program Reynolds has carried on during the past few years to educate the housewife to the extraordinary protective value of aluminum foil for the storage of perishable foods in her own kitchen. As a result of the quick acceptance of foil as a kitchen product, the housewife has become thoroughly familiar with it and now regards it as providing complete protection against loss of flavor, moisture, and freshness.

◆ ◆ ◆

The addition of a new line of small instrument air valves has just been announced by Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio. These instrument air valves, manufactured by Hoke, Inc., Englewood, N. J., are equipped with Crawford Swagelock ends to provide leakproof and torque-free seals on every type of instrumentation installation. An arrow embossed on the valve body shows direction of flow. At present, these valves are being made in brass, aluminum, steel, and stainless steel. They are available in the small sizes from stock at Crawford Fitting Company and Swagelock Distributors.

◆ ◆ ◆

A new retort control system which enables the canner to match the controller to the process and to add any desired degree of automation has been announced by The Foxboro Company, Foxboro, Mass. The system consists of the basic Foxboro Controller, which may provide single control (temperature) or dual (temperature and pressure); and a subpanel to which units are added for any type or degree of retort control up to, and including, fully automatic. Subpanel units consist of a cook timer, a cool timer, a cook selector and an automatic venting unit. Any or all of these components and

their related solenoid valves may be added as process needs develop and as greater degrees of control are necessary. Adding a cook timer to the subpanel permits the operator to dial the desired cooking time, the timed period starting when retort temperature is up to its pre-set value and ending by automatically closing the steam valve. Adding a cool timer to the subpanel, in addition to the cook timer, makes the entire retort cycle (excluding venting on steam cooks) completely automatic for any one of the three basic types of cook. If it is desired to handle different types (steam cook, water cook, and steam cook with pressure cooling) from the same control system, a cook selector switch is added. Lights signal the progress of the cycle. Units are easily installed by the purchaser; no special tools or skill required. Wires are coded and terminals clearly marked. Complete application engineering details will be sent on request.

◆ ◆ ◆

The flow of solid materials in chutes, bins, and hoppers is currently being investigated at the Clifton, N. J., research laboratories of the Richardson Scale Co. Before long, the company hopes to evolve a general equation for the flow of solids in any bin of symmetrical shape, which should be of considerable use to bin designers. Engineers know a lot about how liquids behave in motion, but little about the characteristics of solids in flow. Significantly, there is not much known about the flow of solids in bins and similar vessels. Information is largely restricted to a few materials in large cylindrical silos, the flow of earth in dams and retaining wells, and occasional data on some materials in a few types of bin configurations. So far, research engineers at the lab have collected considerable information on the pressure exerted by different materials on the bin discharge opening. They have also collected much on the lateral and vertical pressures existing at different points within the material mass. To test equations and theories evolved, the solids-flow laboratory is equipped with a hydraulic load cell and a series of varying bin sections. With the arrangement, engineers are able to closely study the relationship between various heights of material in a bin and the pressures at the discharge opening. A model bin section with variable side slopes was constructed to permit the observation of typical flow within a bin. A plate-glass front on the cross-section allows direct observation. Photographs and motion pictures have been taken of numerous flow runs and filed for future reference. Another piece of original equipment built for the lab is a machine called a K-determinator. With the machine, it is possible to evaluate the relation between lateral and vertical pressure for various materials under load conditions in a bin.

### . . . *the literary corner*

*What's New in Food and Drug Research*, monthly publication of Food Research Laboratories, Inc., 48-14 Thirty-third St., Long Island City 1, N. Y., presents this interesting tidbit under the title, "Coming—A Survey of Food Research:"

"A comprehensive nationwide survey of current research projects in the field of food and nutrition is soon to be published under the auspices of the Food and Nutrition Board of the National Research Council. This report will list the research topics, the institutions, agencies, or companies supporting or conducting the research, and the personnel associated therewith. It will cover all aspects of technology, digestion, and metabolism, nutrition and disease connected with the production and consumption of food. Such reviews are valuable not only for the facts they reveal as to current emphasis and trends, but because they help to avoid duplication of research effort. The survey was sup-


for flavors

that make

them ask

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GIVAUDAN FLAVORS have provided keys to sales success for many manufacturers—of confections, ice creams, soft drinks, baked goods, puddings, cordials and other products.

Our chemists and flavor experts have developed a complete, quality line of basic flavor materials, natural fruit flavors and imitation flavors to meet every need. They will gladly help you select the right flavors for your products...or work closely with you to develop distinctive individual flavors to meet your special requirements.

Givaudan Flavors Inc.

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## FOOD INDUSTRY TOPICS

ported by a grant from the USDA. Previous surveys of this type were published in 1948 and 1950."

Also of interest in the December issue are items on the pending action of the Food and Drug Administration with regard to "de-listing" certain food colors, and on recent findings concerning the use of antibiotics in animal nutrition.

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The story of how modern technology—science and the farmer teamed together—has accomplished the American agricultural miracle is told in a fascinating picture-filled brochure, "The Story of Farm Chemicals," latest in the *This is Du Pont* series. During the past 20 years, while world population has increased 25%, world food production has inched up a scant 5%. Yet, in the U.S. with an 18% increase in population in the same period, food production has leaped ahead by 50%. Reason for this tremendous payoff from America's farm acres, the book points out, is the veritable revolution in farming methods stemming from new farm machines and modern organic chemicals which lay low the farmer's traditional enemies in nature—insects, weeds, plant diseases. Improved varieties of plants and breeds of livestock have, of course, been equally important factors. As American farmers adapt new scientific developments to their operations, a new-found freedom is also being felt throughout rural areas, the brochure shows. Better working conditions, higher living standards, and more leisure for farm workers and owners alike are changing the appearance of both farm homes and country towns. The massive thrust of technology, not social protest, it is shown, has brought to the American farm its vast productivity and fruitfulness. Furthermore, advances in the science and techniques of agriculture have freed larger and larger segments of the population to use their skill in other fields. With world agriculture pushing toward the limits of land which can be used to produce crops, man's solution to the pressures of ballooning population rests in technological developments which will enable us to boost production on lands already under cultivation. The new Du Pont booklet points out dramatically how developments of industrial and governmental research, resulting in improved farm practices, are accomplishing this increase in food. Provided with modern technical knowledge and the climate of freedom and reward which spawn great achievement, scientists possess the ability necessary to eventual solution of man's oldest and most basic problem—the assurance of ample food for all—the Du Pont book concludes.

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An excellent follow-up article on the techniques of volatile essence recovery as demonstrated by the Eastern Regional Research Laboratory, USDA, is featured in the current *The Givaudan Flavorist* (No. 3, 1953), published by Givaudan Flavors Inc., 330 W. 42nd St., New York 36, N. Y.

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Bulletin CP-50 on "Chemical Porcelain" has just been released by the U. S. Stoneware Co. The 8-page bulletin fully illustrates and describes the company's complete line of chemical porcelain including pipe, fittings, spacers, vertical check valves, swivel joints, expansion joints, sight glasses, flanges, ejecters, and tower packing. Copies may be obtained by writing Mr. Stanley Craig, The U. S. Stoneware Co., Akron 9, Ohio.

◆ ◆ ◆

*The N. C. A. Bulletin* for December 1953 is devoted to the Illinois Candy Industry—Congressional meeting held in Chicago on December 9. Over 75 industry members and 4 Congressional Representatives attended the conference. Candy's stake in agriculture, in foreign trade, and in consumer acceptance was emphasized by 5 key speakers—Col. John D. Peterman, QM Food and Container Institute; Theodore Stempfel, E. J. Brack & Sons; Victor H. Gies, Mars, Inc.; William F. Olsen, Curtiss Candy Co.; Chas. F. Scully, Williamson Candy Co.; and Philip P. Gett, president of the National Confectioners' Assn. The speeches are reprinted in the December *Bulletin*. Congressmen present were Lee E. Allen, chairman, House Rules Committee; Edgar A. Jonas; Chauncey W. Reed, chairman, House Judiciary Committee; and Timothy Sheehan.

### . . . *meeting hall and conference room*

Two divisional meetings of considerable interest were held in conjunction with the 1954 Annual Convention of the Association of American Soap & Glycerine Producers, Inc., New York City, January 26-28. The Association's Glycerine Division, meeting on January 27, heard reports on the following: "The Periodate Method of Glycerine Analysis," by Dr. C. S. Miner, Jr., Miner Laboratories; "Trends in Toilet Goods Affecting the Use of Glycerine," by Dr. E. G. McDonough, Evans Research and Development Corp.; and "The Economics of Glycerine—Today and Tomorrow," by Mr. E. Scott Pattison, manager of the Glycerine Division.

At the meeting of the Fatty Acid Division, Dr. H. E. Longenecker, dean of the Graduate School, University

(Continued on page 40)

# THE TWINS THAT WIN:

Fragrance

Flavor

BOTH FOUND IN ONE PRODUCT

## ZIMCO® Vanillin

*The Original Lignin Vanillin*

**ZIMCO's outstanding excellence and uniformity of flavor are the result of its exclusive, patented manufacturing process . . . developed through years of scientific experiment and research.**

**Remember . . . your best source of finished, ready-to-use flavors is your flavor manufacturer. Ask him about ZIMCO, the *Original* pure Lignin Vanillin. *There's nothing finer.***

**Zimco Vanillin is noted for Quality and Dependability.**

*Consult Your Flavor Supplier*

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SUBSIDIARY OF STERLING DRUG INC.

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**WORLD'S LARGEST SUPPLIERS OF VANILLIN**

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Emergency deliveries from: Atlanta, Dallas, Evanston (Ill.), Los Angeles, Portland (Ore.), Rensselaer (N.Y.), St. Louis and San Francisco

## FOOD INDUSTRY TOPICS

(Continued from page 38)

of Pittsburgh, discussed fats and oils research at the university. Trends in the use of fatty acids for alkyd resins, for emulsifiers, and for plasticizers, plus recent engineering developments were discussed at a later session.

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*First annual award of appreciation from the Pennsylvania Canners Association was presented to Mr. Jesse M. Huffington, Continental Can Company crops consultant, at the recent convention in Harrisburg, Pa. Mr. Huffington (center) is shown receiving the special award from association president A. Reed Hayes (left), while Mr. J. E. Baldwin, packers can sales manager for Continental's Eastern Division, stands by. Based on Mr. Huffington's 26 years of service to Pennsylvania canners and growers, the award plaque reads, " . . . for his numerous contributions to the welfare and advancement of the canning industry in the Keystone State." Founder of Pennsylvania's Ten-Ton Tomato Club in 1930, Mr. Huffington has played a large part in developing the state's tomatoes into a nationally-famous product. Mr. Huffington joined Continental in 1948 and now travels from his offices at the company's Baltimore headquarters to work with growers, business, and professional people from Maine to Florida.*

◆ ◆ ◆

Mr. E. W. Tinker, executive secretary, American Paper and Pulp Assn., was guest speaker at a recent National Starch Products staff meeting held at the company's New York City headquarters. Mr. Tinker's talk covered the various problems encountered in the paper and pulp industry and their relation to suppliers of starches and adhesives. Mr. Frank Greenwall, company president, reviewed the firm's progress and growth


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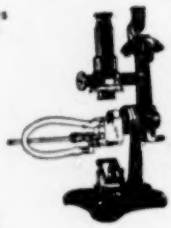

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For estimating the bacterial concentration in dairy products.

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INSTRUMENT DIVISION
BUFFALO 15, NEW YORK

during 1953. He also pointed out to the group the organization's proposed plans for expansion of the Indianapolis plant and for the further increasing of the company's capacity for producing vinyl acetate polymers and copolymers.

### . . . *building up and branching out*

Arthur D. Little, Inc., will open a western regional office in San Francisco early in 1954 according to an announcement by Dr. Earl P. Stevenson, president. The rapid industrial growth on the West Coast prompted the establishment of the new office where it can contribute to the continued growth and success of this industry. Mr. Christian J. Matthew, a long-term employee of the firm in Cambridge, Mass., will be in charge, with Mr. Richard Newhall of San Francisco as an associate. In addition to work on assignments for western clients, they will provide liaison with the company's main research organization in Cambridge. Arthur D. Little, Inc., established in 1886, is active in all fields of applied science and has a large staff for technical-economic studies including operations research and area development groups.

◆ ◆ ◆

Transparent Package Co. (Tee-Pak), Chicago, one of the largest manufacturers of artificial casings for meat in the world, celebrated the 20th anniversary of its incorporation December 15. Company plants occupy more than 175,000 square feet at two locations. Company products are artificial casings for sausage and other types of flexible film packages for food products. Tee-Pak also has perfected many types of processes for printing and sealing film. Its products are distributed through sales offices in the U.S., Canada, and many foreign countries. The company continues to give major attention to new technical developments in its field with the maintenance of a very large research and development staff and the most modern laboratories and equipment.

◆ ◆ ◆

A small army of craftsmen and workers at the 900 Van Nest Avenue building of Florasynth Laboratories, Inc., are rapidly completing the new executive offices and Eastern production facilities of the New York City firm. Climaxing months of construction activity, the many workrooms and laboratories for distilling, extracting, and other processes wil comprise one of the most modern and complete establishments for research and manufacturing in the country. It will be ready for occupancy early in 1954. Mr. Wm. Lakritz, president, states that the spacious 3-story, 70,000 square foot building will enable Florasynth to enhance still further its laboratory, technical, manufacturing, storage, and service facilities for each one of the fields in which the company has been an important supplier of materials for many years.

◆ ◆ ◆

American Cyanamid Company, New York City, recently announced the reorganization of its development functions.

(Continued on page 44)

Brewers' Dried Yeast
improves flavor and nutrition
prolongs freshness
in Breads, Rolls, Donuts, Cakes, Crackers and other baked products.
The incorporation of inactive Brewers' Dried Yeast contributes the natural vitamin B complex, certain still unidentified, but nutritionally important PLUS factors, and increases the protein value by providing all essential amino acids. In addition, it produces superior flavor, a tender crumb, rich crust color and delays staling.
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Chicago 11, Ill.
Brewers Dried Yeast—Natural Source of Nutrition and Flavor
Brewers Dried Yeast
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**Get rich "home-made taste"**

. . . in your brand of canned gravies or meats—then watch sales soar! It's easy, with natural, wholesome Huron MSG. Write Huron's Technical Service about your particular flavor problem. The Huron Milling Co., 9 Park Place, New York City 7.

**HURON MSG**

PURE MONOSODIUM GLUTAMATE 99+%

**Made by the pioneers in protein derivatives**

# What makes people fat?

People get fat simply because they overeat

Why do they overeat?

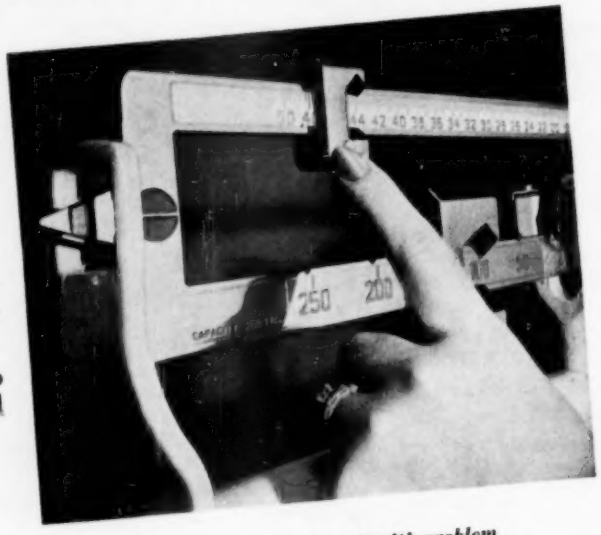
Because they're hungry

Why are they hungry?

One of the reasons in healthy individuals is because their blood sugar level is low

What is the fastest way to raise the blood sugar level and help keep from overeating?

Sugar and the good things containing it!



***Nutritional research has taken a new look at our number one health problem and discovered how sugar helps keep your appetite and weight under control***

There is a new nutritional term that you will soon be hearing a lot more about.

It is your "*blood sugar level.*"

Research scientists at one of our leading universities have discovered that your blood sugar level plays an important role in determining how hungry you are.

***Nature's "Hunger Thermostat"***

When your blood sugar level is *low* you are "hungry as a bear." When it is *high* the healthy person finds it easier to turn down the extra helpings of food that mean extra pounds. It turns your appetite on and off in much the same way that a thermostat regulates the heating system in your house.

If you are watching your weight, this is important news—you can raise your blood sugar level, *tame your runaway appetite* any time you want to. Just eat or drink something with sugar in it.

Sugar is assimilated into the blood stream and used as energy faster than any other food. It satisfies your craving for food faster than any other thing you can eat, because it *almost immediately* raises your blood sugar level.

**That is why an 18-calorie spoonful of sugar in your coffee or tea may make it easier for you to cut 100 or more calories from your diet.**

*That is why*, when you round off a small meal with a simple dessert you get as great a feeling of satisfaction as you would from a much larger meal providing far more calories.

*That is why* something with sugar between meals not only revives your energy, but helps you to keep your *appetite within bounds* at the next meal!

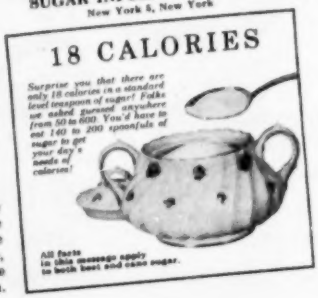
***Sugar Substitutes Not Effective***

Naturally you cannot expect the same help from chemical sweeteners which have no effect on your blood sugar level. Since they do nothing to curb your appetite, you may find that, by using them, you are eating *more calories* than they save you.

The best way to get the protein, vitamins, minerals and *energy* we need is in a well-balanced selection of foods that nature made us like.

Nature is sugar's best salesman. Sugar must be one of our most needed foods—*that's why we like it so much.*

**SUGAR INFORMATION, INC.**
New York 5, New York


18 CALORIES
Surprise you that there are only 18 calories in a standard level teaspoon of sugar? Folks we asked guessed anywhere from 50 to 600. You'd have to eat 140 to 200 spoonfuls of sugar to get your day's needs of calories!
All facts in this message apply to both beet and cane sugar.

**Here's the first ad—one that answers a question that's on everybody's mind, with the latest facts from research at a leading university. It appears as a full page ad in Life, January 18; The Saturday Evening Post, January 23; Look, February 23; New Yorker, February 20; Ladies' Home Journal for March, and in newspapers from coast to coast on January 14 and 15.**

# SUGAR SPEAKS

## Entire Industry supports Advertising Program reporting new facts about one of our most vital foods

**5 Leading Magazines, 39 Big-City Newspapers to Carry Sugar's New Story**

The great hassle over calories has stirred up so much public confusion that it is time to clear the air.

So the men who are responsible for supplying the food industry with 8,000,000 tons of sugar a year are going to tell people the facts about the nutritional importance of sugar—not only in normal diets, but in reducing diets as well.

The program gets under way this month with one of the most newsworthy ads ever published in the interests of any food. It's reproduced on the facing page. Read it and we think you'll agree that it—and others like it—will go a long way toward shaping sound, favorable attitudes about diet that will help keep this the best-nourished nation on earth.

**SUGAR INFORMATION, INC.**
New York 5, New York

# sweet'en-er

That which sweetens or imparts a sugarlike flavor

## *Example:* GLYCERINE!

In products like cough drops, toothpastes, candies, capsules, and medicines, where Glycerine's major properties make it an important ingredient, Glycerine's pleasant taste is an extra "plus." Glycerine not only acts as a humectant, demulcent, solvent, plasticizer or preservative in formulations of this type, but also enhances their flavor.

U.S.P. Glycerine is nontoxic and easily digested. Its applications in food processing have been accepted by the American Medical Association Council on Foods, and permitted by Federal and State food and drug authorities.

If you're developing a product that must have any of the properties mentioned—and be palatable too—check Glycerine.

## New Pectin Jelly

For example, a concentrated pectin jelly composition was recently patented. When dissolved in hot water and then cooled, this solid aqueous gel forms a larger volume of edible jelly dessert. Glycerine acts as a sweetener.

## Balance of Properties

Glycerine's sweetening action is only one part of the story. You can count on *versatile* Glycerine to serve as—

| | |
|---|---|
| **preservative** | **bodying agent** |
| **bacteriostatic** | **stabilizer** |
| **lubricant** | **antifreeze** |
| **penetrant** | **blending agent** |

***Booklets on the application of Glycerine in the drug and cosmetic and food fields are available. For your copy, write Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.***

*Nothing takes the place of Glycerine*


## FOOD INDUSTRY TOPICS

(Continued from page 41)

Under the new organization, there will be 3 departments: Fiber Development, with Mr. C. W. Bondige as manager; Market Research, with Mr. Borden R. Putnam, Jr., as manager; and New Product Development, Dr. Nolan B. Sommer, manager. Mr. Bondige will supervise commercial evaluation of experimental textile fibers developed by the company. These, so far, have included acrylic fibers all known by the experimental designation of "X-51." Mr. Putnam will supervise market surveys to determine the advisability of plant expansions, product diversification, and development of new products, as well as long-range studies on development of new raw materials, processes, and products. Dr. Sommer will be in charge of the development of markets for new products available from the firm's research laboratories and pilot plants.

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On November 20, Mr. John L. Cassullo, president of Dodge & Olcott, Inc., was host at a press cocktail party to introduce the firm's newly constructed laboratory facilities to the industry. The 9 new laboratories were thrown open and guests invited to tour at will through the departments of particular interest to their readers . . . flavor, perfume, or industrial odorant . . . and the D&O technical personnel were on hand to answer specific questions. The new facilities include a product development department as well as new laboratories for work on specific problems in flavors for the food, confectionery, beverage, and pharmaceutical industries and perfume bases for cosmetic and industrial application. An organic synthesis and analytical laboratory is still under construction, and still another for aerosol testing will soon be started.

### . . . *the human element*

Dr. Samuel Cate Prescott, professor emeritus of the Massachusetts Institute of Technology, authority on food preservation, and founder member of the IFT, was the recipient of the first annual Service Award presented by the 49ers, an organization that serves the canning machinery and supplies association. The award, in the form of a plaque and scroll, was given to Dr. Prescott by Mr. Robert A. Sindall, Jr., president, at a meeting of the 49ers held in conjunction with the annual convention of the National Canners Assn., Atlantic City, Jan. 22. Dr. Prescott was honored for his outstanding achievements and service to the canning and allied industries. He is renowned throughout the industry for his work in applying the principles of bacteriology to factory operations, resulting in practical methods of food preservation and sterilization. Since his retirement 12 years ago, he has been a consultant for the Dehydration Department, USDA, and for the Research Laboratories of the National Canners Assn. He has been the recipient of many honorary degrees, and other recognitions include a citation for civilian service from the War Department and the Nicholas Appert Medal from the Chicago Section of the IFT for preeminence in the field of food technology. He has also received the Institute's Stephen M. Babcock Award and last year was presented with the Institute's First Annual

Citation. Dr. Prescott is widely known throughout the canning and allied industries for his writings and co-authorship of many papers and treatises on various phases of bacteriology and food technology.

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The retirement on December 1, 1953, of Dr. Berton S. Clark, scientific director of American Can Company's research and technical department, closed a career of 38 years with the can-making firm during which he was credited with many important contributions to the advancement of canning and container manufacturing. The scientist was honored on November 30 at a testimonial dinner in Chicago attended by more than 150 members of the can-using and can-making industries, fellow-scientists, and his associates in the can company. In reviewing Dr. Clark's scientific work since he joined Canco's chemical department in New York City in 1915, Dr. Roger H. Lueck, general manager of Canco's research and technical department said: "Although Dr. Clark's contributions to the advancement of canning and can-making technology have been noteworthy, those in the field of administration of laboratory organizations have been equally so. By precept and example he has demonstrated an outstanding ability to create within an organization devoted to industrial research a climate conducive to scientific inquiry. His attributes of curiosity, patience, persistence, and thoroughness have served to inspire others in his organization over a period of many years."

**Dr. B. S. Clark, scientific director of American Can Company, is honored at his retirement dinner as he receives watch from Dr. Roger H. Lueck, general manager of Canco's research and technical department. (Left to right) Dr. R. W. Pilcher, Canco's director of research; Dr. Lueck, Dr. Clark and M. P. Cortilet, vice president of the can company's Central division.**

Dr. Clark graduated from St. Lawrence University in 1911 and since that time has played a leading role in the fields of chemical, food, and container research. His many activities benefiting the canning industry include contributions to the development of corrosion-resistant tin plate, the hydrogen evolution test used in the steel industry to determine the performance of tin plate for cans, and numerous other projects to improve food products and the metal and fibre containers in which they are packed. Dr. Clark has served in many im-


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**176 West Adams Street**

**Chicago, Illinois**

## FOOD INDUSTRY TOPICS

portant scientific capacities and is president this year of the Institute of Food Technologists. He has been a consultant to The Quartermaster General on foods and packaging and to the USDA on the utilization of surplus farm products. In 1941, President Roosevelt appointed him a delegate to the National Nutrition Conference and during WWII he served as chairman of the Technical Committee of the Can Manufacturers Institute. He is a member of the Munitions Board, packaging industry advisory committee, Nutrition Foundation, food industries advisory committee, Food Technology Council, Illinois Institute of Technology, and the Quartermaster Association. Dr. Clark is a member of Sigma Alpha Epsilon, the Old Guard Society, and the Commonwealth Club of San Francisco. He is married and resides in Oak Park, Ill.

◆ ◆ ◆

Mr. Jeffrey P. Pfaff, recently appointed manager of the Midwest Division of the Huron Milling Company, will direct the company's sales and promotional programs in the 11 states which comprise the Huron Midwest Division. A Huron representative since 1946, IFT member Pfaff had covered Illinois and Indiana, and, recently, the Chicago area. According to Huron, the appointment is the latest in a series of organization changes designed to provide better service to the firm's

IN-PLANT CHLORINATION AT THE WINTER GARDEN COMPANY, KNOXVILLE, TENNESSEE

134

**SAVES MONEY**--Over $750 was saved in 3 months on labor alone through more efficient clean-up by means of In-Plant Chlorination at this plant.

**ELIMINATES SLIME**--According to the company president, Mr. W. Ed. Booker, "***Three days after chlorination was started the floors were spotlessly clean and remained so throughout the season.***"

**CONTROLS BACTERIA**--Reduction in bacterial counts of up to 93% were obtained by the Winter Garden Company on inspection belts and such equipment as graders, snippers, etc., with In-Plant Chlorination.

In-Plant Chlorination can bring these and other advantages to your plant, too. Just call your nearest W&T Representatives for complete information.

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customers in the laundry starch, wallpaper paste, and food seasoning fields.

◆ ◆ ◆

Gen. Mark W. Clark, former US and UN Supreme Commander in the Far East, has been elected a director of Consolidated Grocers Corp., it was announced by Mr. Nathan Cummings, board chairman, who stated: "Gen. Clark's broad experience in organization and administration will make his counsel of great value to our company's expanding activities. Gen. Clark resigned from active duty Oct. 31 after 40 years of brilliant Army service which brought him military honors and recognition from his own country and many foreign governments. He recently accepted an appointment as president of the Citadel, the military college of South Carolina, in Charleston, where he and Mrs. Clark will make their home.

GENERAL CLARK

◆ ◆ ◆

KOCH

Dr. Robert B. Koch has joined the research staff of the J. R. Short Milling Co., Chicago, according to word from Dr. Chas. G. Ferrari, technical director. Dr. Koch was formerly research assistant to Dr. R. A. Larsen, chief, Cereal and Baked Products Division, QM Food and Container Institute, Chicago. He took his graduate work at the University of Minnesota under the direction of Dr. W. F. Geddes. Dr. Koch will be assigned to the study of enzymes—one of the special interests of the J. R. Short Milling Co.

◆ ◆ ◆

Mr. Hans Zullig, developer of the original Real Gold fruit beverage formulas, has joined the newly formed Real Gold Company as director of quality control. Mr. Zullig joined Real Gold Citrus Products in 1943 and is responsible for developing the now famous formulas for orange, lemon, and grape beverages. The Real Gold Company attributes its annual sales of over 2,000,000 cases to a great extent to Mr. Zullig's formula. A native of Switzerland, he is a graduate of the technical college at Winterthur, and is a member of the IFT and the ACS.

◆ ◆ ◆

Polak's Frutal Works, Inc., Middletown, N. Y., announced the retirement January 1 of its president, Mr. Jac. Polak, who has been connected with the essential oil industry for over half a century. Mr. Polak will

(Continued on page 48)

P&S

NEW

BAK-O-FLAVORS

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**The choice is yours . . . the quality is P & S . . . and the taste thrill goes to the consumer.**

Bak-O-Flavors (laboratory-developed by P & S to withstand high oven temperatures) are excellent for commercially baked goods, prepared mixes or any product in which the flavor must undergo high temperature processing.

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## FOOD INDUSTRY TOPICS

(Continued from page 47)

continue as board chairman and his elder son, Mr. Frits J. Polak, has asumed the presidency. Other officers are: Mr. Bernard Polak, vice president; Mr. Alexander H. Micheels, asst. vice president; Mr. John ter Veer, secretary; Mr. Erik Vles, treasurer; Mr. Ernest Polak, director of research. The company, founded in Amersfoort, Holland, 40 years ago, has conducted an American operation since 1921. By 1946, seeking more spacious surroundings, the company transferred its operations from Long Island City to a greatly enlarged plant in Middletown, N. Y. The main seat of the organization was set up in the U. S. A. and became the headquarters for the worldwide activities of Polak's Frutal Works and its associated companies in Holland, England, Belgium, France, and Germany. The firm also maintains a branch office in Chicago and agencies and stocks in various cities in this country and in Canada.

◆ ◆ ◆

Riegel Paper Corp., New York City, announces the appointment of Mr. C. W. Hoffman as assistant manager of Converted Glassine Sales. An IFT member, Mr. Hoffman's background includes 18 years of technical and operating experience in the mills, and 9 years of sales and technical service work among Riegel customers.

◆

FOOD RESEARCH, companion journal of FOOD TECHNOLOGY, reaches over 500 foreign subscribers. Of these, many are contributors and as a consequence first-hand knowledge of overseas progress in food science is available to FOOD RESEARCH readers.

## EMPLOYMENT NOTICES

**WANTED—Food Engineer or Chemical Engineer for Materials Handling in large Chicago food processing plant. Recent graduate to 5 yrs. experience preferable. Administrative ability and supervisory potential highly desirable. Excellent opportunity for future management positions. Send resumé and snapshot to BOX 312 Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Ill.**

**CHEMIST - CHEMICAL ENGINEER**

**Well established food industry located in central New York offers an opportunity for a young man in its laboratory. Diversified activities in quality control and research development.**

**Prefer young man with B.S. Degree and up to five years experience in food manufacture or allied field. Send resumé and salary requirements in first letter. All replies held confidential. REPLY BOX 310, Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Ill.**

**BIOCHEMICAL DIRECTOR, Ph.D. to take charge of laboratory group concerned with biochemical aspect of microorganisms. Experience in similar capacity desirable. Company is nationally known in the food industry. Please send complete resumé and photo. REPLY BOX 314, Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Ill.**

**POSITION WANTED: Chemical Engineer - Food Technologist, M.Ch.E. Six years pilot plant research and development of bakery premixes, syrups, sauces and food specialties. Desires position in research or technical sales-service. REPLY BOX 311, Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Ill.**

**FOOD CHEMIST. Ph.D. or equivalent in experience to direct new laboratory section concerned with development of new food and feed products. Medium-sized, well-established company. Please send complete resumé and photo. REPLY BOX 313, Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Ill.**

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**by Lloyd B. Jensen, Ph.D.**

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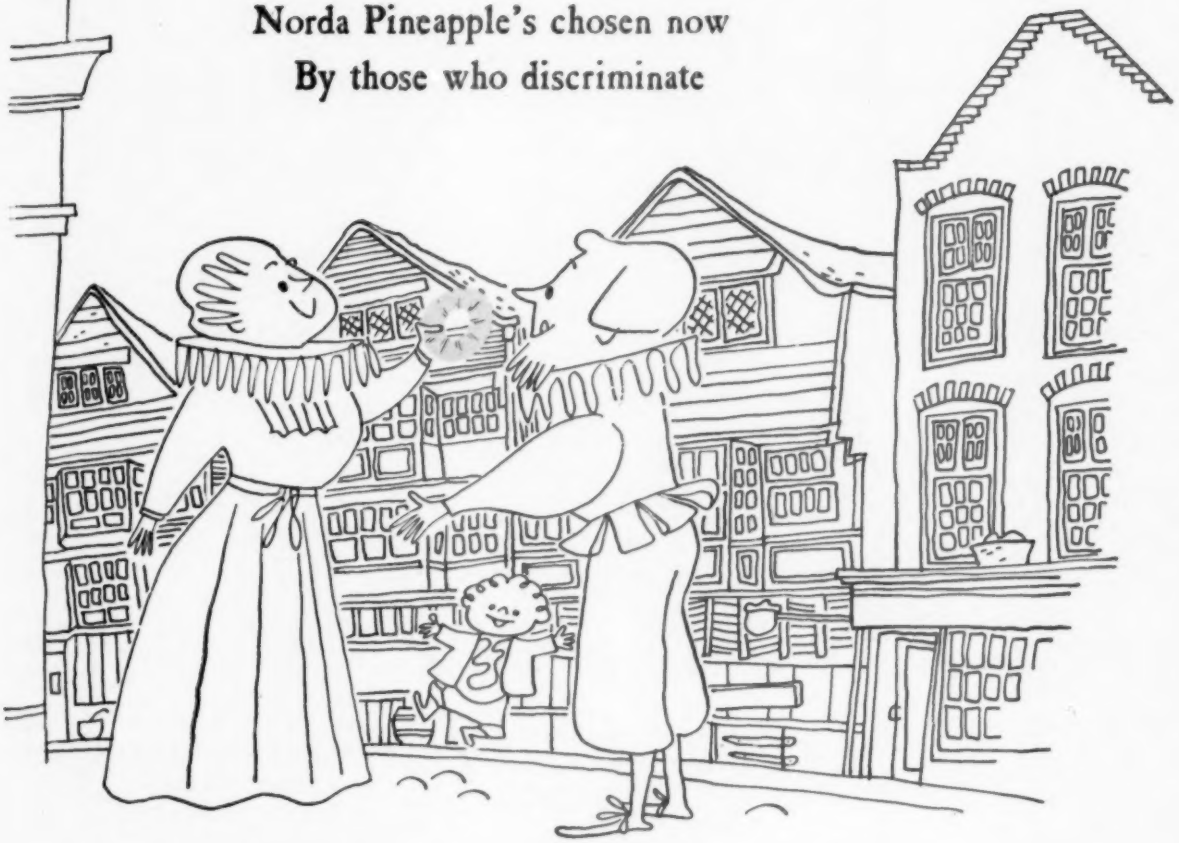

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